DOCUMENT RESUME

ED 041 772 24 SE 009 329

AUTHOR	Mechling, Kenneth R.
TITLE	A Strategy for Stimulating the Adoption and Diffusion of Science Curriculum Innovations Among Elementary School Teachers, Final Report.
INSTITUTION	Clarion State Coll., Pa.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-9-B-053
PUB DATE	Nov 69
GRANT	OEG-2-9-480053-1043(010)
NOTE	92p.
EDRS PRICE	EDRS Price MF-$0.50 HC-$4.70
DESCRIPTORS	Comparative Analysis, *Curriculum, Diffusion, *Educational Change, *Elementary School Science, *Inservice Teacher Education, *Instructional Innovation, Teacher Characteristics, Teacher Education
IDENTIFIERS	Minnesota Teacher Attitude Inventory, Rokeach Dogmatism Scale

ABSTRACT

This study investigated means by which innovations in elementary science teaching may be efficiently diffused to classroom teachers. Selected teachers were used to adopt innovations and to extend the innovations within their schools. Subjects were drawn from 1,205 elementary teachers teaching in 112 elementary schools in western Pennsylvania. Sociometric measures were administered to identify the science opinion leader and non-leader in each school. Twenty science opinion leaders and twenty-one non-leaders, each representing a different school, were randomly selected to attend an inservice program. These teachers were administered the Rokeach Dogmatism Scale and The Minnesota Teacher Attitude Inventory. A questionnaire was administered pre-and post-to all teachers in the schools involved to measure changes in science teaching. The findings of the study indicated that neither adoption nor diffusion is facilitated by concentrating efforts on teachers identified as science opinion leaders. Dogmatism scores were significantly related to the adoption of innovations, with low dogmatic teachers showing greater changes. The Minnesota Teacher Attitudes Inventory proved of little value in identifying teachers likely to adopt innovations. (EB)

ED041772

BR-9-B-053
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Final Report
Project No. 9-B-053
Grant No. OEG-2-9-480053-1043(010)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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A Strategy for Stimulating the Adoption and Diffusion of Science Curriculum Innovations Among Elementary School Teachers

Kenneth R. Mechling

Clarion State College

Clarion, Pennsylvania 16214

November 1969

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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SUMMARY

Numerous science curriculum development projects have expended enormous quantities of time, effort, and money to produce innovative science teaching activities and materials intended for use in the nation's elementary school classrooms. Based on modern psychological models and designed to involve children in the processes of science, the innovations offer much promise for improving science instruction at the elementary school level. Unfortunately, even after years of the development and production of the innovations, a significant gap continues to exist between availability and implementation. The vast majority of elementary teachers have not yet adopted the innovations. Most appear to go on with their usual teaching routines unaware of the new developments. The thrust of this investigation was towards the discovery of the means by which science teaching innovations may be most efficiently diffused to the level of the classroom teacher.

The purpose of this exploratory study was to examine a diffusion strategy for science education which employed selected elementary teachers to adopt science teaching innovations and spread them to other classroom teachers within their schools. Specifically, it sought to determine (1) whether teachers designated by their peers as science opinion leaders adopted and diffused more innovations in science teaching methods and materials than teachers not designated as science opinion leaders; and (2) whether the adoption of the innovations was significantly correlated with scores achieved by teachers on either the Rokeach Dogmatism Scale or the Minnesota Teacher Attitude Inventory.

The subjects who participated in this study were drawn from 1,205 elementary classroom teachers from 112 elementary schools in western Pennsylvania. On the basis of the classification variable, science opinion leadership, two groups of teachers were randomly selected for inclusion in the study. One group consisted of twenty science opinion leaders and 134 teachers from the schools which they represented. The other group included twenty-one nonleaders and 119 teachers from the schools which they represented. Each science opinion leader and nonleader represented a different elementary school.

In January 1969, each teacher in both groups received a pretest questionnaire to establish his level of adoption of ten innovative science teaching investigations characteristic of those produced by three major elementary science curriculum development projects. A sociometric measure was administered concurrently to identify the science opinion leader and nonleader in each school. During March 1969, the twenty science opinion leaders and twenty-one nonleaders participated in three sessions of a science inservice program. After the Rokeach Dogmatism Scale and the Minnesota Teacher Attitude Inventory had been administered, the participants

were instructed in the techniques for using the methods and materials of the ten innovative science investigations in their own classrooms. During May 1969, the level of adoption questionnaire was again administered as a posttest to all teachers. Pretest scores were subtracted, algebraically, from posttest scores to yield change in level of adoption.

Statistical treatments included the following: t-tests for uncorrelated data were used to determine whether significant differences in pretest levels of adoption existed between the groups compared; single classification, completely randomized analyses of variance were used to determine whether science opinion leaders adopted and diffused more innovations than nonleaders; and 2 X 2 contingency tables were used to test the relationships between change in level of adoption and scores on the Rokeach Dogmatism Scale and the Minnesota Teacher Attitude Inventory.

The pertinent findings of this study were:

1. Science opinion leaders who participated in the science inservice program dealing with innovative science teaching techniques and materials adopted no more of the innovations than nonleaders who participated in the same program.
2. Teachers from schools which were represented in the science inservice program by science opinion leaders adopted no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders.
3. There was a significant correlation between scores on the Rokeach Dogmatism Scale and change scores on a measure of level of adoption of science teaching innovations among participants in the inservice program. An inverse relationship existed between the scores on the two instruments. Most teachers who scored high on the Rokeach Dogmatism Scale scored low on change in level of adoption. Most teachers who scored low on the Rokeach Dogmatism Scale scored high on change in level of adoption.
4. There was no significant correlation between scores on the Minnesota Teacher Attitude Inventory and change scores on a measure of level of adoption of science teaching innovations among participants in the science inservice program.

It was the thesis of this exploratory investigation that some means should be devised to facilitate the spread and adoption of worthwhile curriculum innovations in science education methods and materials to elementary classroom teachers. The findings of this study indicated that the adoption and diffusion processes were not facilitated by the identification of science opinion leaders and the concentration of science inservice efforts upon them. Teachers who were not regarded as science opinion leaders were equally effective in adopting and diffusing science teaching innovations as teachers regarded as science opinion leaders; therefore, no advantage was gained by concentrating inservice efforts upon the opinion leaders.

The relationships between the adoption of innovations and scores on the Rokeach Dogmatism Scale and the Minnesota Teacher Attitude Inventory were explored in an effort to identify individual teachers who were likely to adopt science education innovations. The results indicated that the MTAI is of little value as a tool for identifying such teachers. Conversely, a significant relationship was found between the Rokeach Dogmatism Scale and the adoption of science teaching innovations.

Although this finding should properly be regarded as tentative, it may provide a basis for further research. If the dogmatism scale can be used to identify teachers who are likely to adopt science curriculum innovations, then such a finding may have important implications for change agents in science education. The possibility of utilizing low dogmatic teachers as points of innovational input deserves further exploration in an effort to find clues for facilitating the implementation of educational innovations.

INTRODUCTION

THE NATURE OF THE PROBLEM

In recent years, American education has witnessed unprecedented activity in the development of innovative instructional materials for elementary school science. Curriculum designers, aware of the explosive growth of scientific knowledge and disenchanted with contemporary science curricula, have grappled with a task spelled out a decade earlier by Conant when he said, "What is needed are methods for imparting knowledge of the tactics and strategy of science to those who are not scientists."[1] More than fifteen elementary science curriculum reform projects have responded to this challenge and produced innovative materials and teaching techniques which are based upon modern psychological models and designed to involve children directly in the processes of science. Although the curriculum innovations offer much promise for improving the way science is taught in the nation's elementary schools, their production has seldom been coupled with adequate provision for diffusion and subsequent evaluation by those intended to be the ultimate adopters, namely, the elementary classroom teachers.

Federal funds amounting to more than one hundred million dollars[2] and enormous quantities of time and effort have been invested in the development of the innovative science curricula and yet, as Montean points out, "Unfortunately...the implementation, of what is known and available, is not taking place."[3] The success or failure of any implementation efforts depends on the acceptance and adoption of new ideas by the classroom teacher, but even before this can happen the innovation must reach the teacher.

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1. James B. Conant, On Understanding Science (New Haven: Yale University Press, 1947), p. 26.

2. Wayne W. Welch, "The Impact of National Curriculum Projects: The Need for Accurate Assessment," School Science and Mathematics, LVIII, 3 (March 1968), pp. 225-226.

3. John H. Montean, "Patterns of Implementation," Science Education, LII, 4 (October 1968), p. 316.

The task of diffusing the science curriculum innovations to the teachers expected to use them looms as a formidable one. Its magnitude is revealed in information released by the elementary science curriculum projects themselves. Three large-scale projects with production either completed or well underway have reported their implementation status in terms of numbers of teachers and students using their materials. Science--A Process Approach reported involving an estimated 25,000 teachers and 750,000 students;[4] the Elementary Science Study reported involving 7,500 teachers and 225,000 students;[5] and the Science Curriculum Improvement Study reported involving 600 teachers and 19,000 students.[6] Considering that there are more than 31,000,000 elementary pupils enrolled in elementary schools and more than 1,100,000 teachers teaching them,[7] it appears that ninety-seven per cent of all elementary teachers are not yet using any of these three sets of new materials and techniques which are, by far, the best diffused to date. Apparently, the impact of the elementary science curriculum development projects has yet to be felt at the local school level. The problem of reaching a vast number of elementary teachers is further complicated by teacher turnover. Teachers needed to fill new positions or replace teachers who retire or leave the profession also require exposure to the innovations.

Because of the magnitude of the task of reaching more than one million elementary teachers with the science curriculum innovations, it was the purpose of this study to determine the feasibility of selecting key teachers who were likely to adopt the innovations and who exhibited potential for influencing the adoption decisions of their colleagues. If such teachers could be chosen, a priori, on the basis of reasonable criteria, then change agents might work through them to promote the implementation of educational innovations. Inservice activities could concentrate on such potential adopters who, in turn, could provide a means to diffuse innovations to other teachers within their schools.

An independent variable selected for examination in this study because of its potential for affecting the adoption and diffusion of science teaching innovations was opinion leadership. Individuals to whom others look for advice and information are described by Rogers as opinion leaders.[8] Research findings from studies conducted in rural sociology, medical sociology, and marketing indicate that individuals designated as opinion leaders generally adopt and spread more innovations than individuals not so designated.[9] If opinion leaders can be identified within elementary school faculties, then it may be possible to use them as sources of innovational input from whom science teaching innovations could spread. Wiles, in his summaries of strategies for curriculum change, recognized the need to examine such a strategy when he urged, "...we need to look at our in-service education pattern to see if we should concentrate our money and effort on the innovators and the influentials and let innovation spread from them."[10]

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[4] J. David Lockard, ed., Sixth Report of the International Clearinghouse on Science and Mathematics Curricular Developments 1968, A Joint Project of the American Association for the Advancement of Science and the Science Teaching Center, University of Maryland (College Park, Maryland: The International Clearinghouse, May 1968), p. 152.

[5] Ibid., p. 230.

[6] Ibid., p. 336.

[7] Luman H. Long, ed., The 1969 World Almanac (New York: Newspaper Enterprise Association, Inc., 1968), p. 349.

[8] Everett M. Rogers, Diffusion of Innovations (New York, Free Press of Glencoe, 1962), p. 208.

In addition to the problem of diffusing the innovations to the level of the classroom teacher, there is also the problem of gaining their acceptance once they have arrived. Curriculum innovations in science often reflect changed philosophical and psychological orientations and, therefore, may necessitate fundamental changes in the teaching methods used by the teachers who decide to adopt them.[11] A common objective of the curriculum projects has been to shift the emphasis of science teaching from the teacher-centered methods of lecture, recitation, and textbook reading to pupil-centered experiences designed to increase skills in using the methods of science. Project designers have, in fact, heeded the admonition of the Fifty-ninth Yearbook of the National Society for the Study of Education which advised:

> Scientific methods of investigation by which knowledge may be acquired and tested are now very much a part of our culture. The elementary school should help children become acquainted with these methods.[12]

Elementary classrooms in which the innovations are used are structured so that children and teachers cooperatively study natural phenomena with the approach and spirit of the scientist.[13] Children become active participants in investigation, inquiry, and processes of science such as observation, prediction, measurement and experimentation.[14] The teacher sets the stage for investigation, then functions as a guide or director of learning rather than a teller or conveyor of information. Curriculum developers have actively discouraged teachers from telling children about science or listening while children read about science, both of which seem to dominate elementary science instructional methods.

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[9] Ibid., pp. 208-253.

[10] Kimball Wiles, (ed.), Strategy for Curriculum Change (Washington, D.C.: Association for Supervision and Curriculum Development, 1965), p.73.

[11] David P. Butts, "Widening Vista's In-Service Education," Science Education, LI, 2 (March 1967), p. 131.

[12] Glenn O. Blough, "Developing Science Programs in the Elementary School," Rethinking Science Education, Fifty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: The University of Chicago Press, 1960), p. 113.

[13] Herbert D. Thier and Robert Karplus, "Science Teaching is Becoming Literate," Education Age, II, 3 (January-February 1966), 40-45.

Since the adoption of a science curriculum innovation might require many teachers to change their methods of teaching science, two social-psychological attributes that may be related to teacher acceptance of such changes were examined in this study. One such attribute was dogmatism, which Rokeach describes as a personality variable which governs a person's receptivity to new ideas and includes how he perceives, evaluates, acts and reacts to such ideas.[15] High dogmatic persons, because of the structure of their beliefs, tend to view new ideas as threatening; whereas low dogmatic persons are generally more receptive to change.[16] Therefore, it was expected that high dogmatic teachers would react differently than low dogmatic teachers when confronted with new ideas for teaching science.

The other social psychological attribute examined in this study, which could affect teacher acceptance of the new science teaching techniques and materials, was the classroom social atmosphere which prevails during the teaching of science. Teacher utilization of the innovations in the manner intended by the developers would necessitate the establishment of a relatively permissive classroom atmosphere where pupil-to-pupil interaction, freedom of exploration, and pursuit of individual interests would be encouraged. The teacher is expected to guide pupil-centered activities. It was anticipated, therefore, that teachers who were predisposed to provide or actually providing a rather permissive classroom social atmosphere would react differently to the innovations than teachers whose classroom style was more dominating and authoritative. One of the purposes of this study was to determine if a relationship existed between the classroom social atmosphere maintained by the teachers and their adoption of the science teaching innovations.

If opinion leaders or other teachers possessing certain social-psychological attributes can be selected, a priori, to serve as initial vehicles of change within school systems such a finding may provide important clues for stimulating the diffusion of the science teaching innovations.

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[14] Robert Gagne, "Elementary Science: A New Scheme of Instruction," Science, CLI (January 7, 1960), pp. 49-53.

[15] Milton Rokeach, The Open and Closed Mind (New York: Basic Books, 1960), p. 73.

[16] Ibid., pp. 60-64.

SCOPE OF THE STUDY

The purpose of this investigation was to explore a diffusion strategy for science education which employed selected elementary teachers to adopt science teaching innovations and spread them to other classroom teachers. The study was designed to determine (1) whether teachers designated as science opinion leaders adopted and diffused more innovations in science teaching methods and materials than teachers not designated as science opinion leaders, and (2) whether the adoption of the innovations was significantly correlated with scores achieved by teachers on measures of dogmatism or classroom social atmosphere.

On the basis of the classification variable, science opinion leadership, sixty elementary schools in western Pennsylvania were randomly selected for division into two groups of thirty schools each: Class 1 schools were schools from which science opinion leaders were drawn; and Class 2 schools from which science opinion nonleaders were drawn. Each teacher in all sixty schools received a pretest questionnaire to establish his level of adoption of ten innovative science investigations which were selected as characteristic of those produced by the three major elementary science curriculum development projects. A sociometric measure was administered jointly to all teachers to identify the science opinion leader and nonleader in each school.

Thirty science opinion leaders (Class 1) and thirty nonleaders (Class 2), all from different elementary schools, were invited to participate in three consecutive inservice sessions held at Clarion State College. After measures of dogmatism and classroom social atmosphere were administered, the participants were instructed in the techniques of using the methods and materials of the ten innovative science investigations. Ten weeks after the final inservice session the questionnaire determining the level of adoption of the ten investigations was again administered as a posttest to all teachers in the sixty schools who had responded to the pretest.

Single classification, completely randomized analysis of variance was used to test the significance of the difference in the change in level of adoption scores between the science opinion leaders and nonleaders and between the teachers in the schools represented by each group. The relationships of dogmatism and classroom social atmosphere with change in level of adoption were each tested by a 2 X 2 contingency table.

It was hypothesized that the independent variables included in the analyses would identify teachers in elementary schools most likely to adopt and diffuse science curriculum innovations. If opinion leaders with established communication networks or teachers with certain identifiable social-psychological attributes could be identified and encouraged to promote the adoption and diffusion of science curriculum innovations, then this would suggest an efficient mechanism for disseminating and implementing educational innovations.

STATEMENT OF HYPOTHESES

The hypotheses of this study were formulated following a review of the characteristics of the elementary science curriculum project innovations and the professional literature concerning the adoption and diffusion of innovations. A comparison of the opinion leader and nonleader classifications and their relative influence on the adoption behavior of other persons led to the proposition of hypotheses H_{o1} and H_{o2}. The characteristics of the elementary science innovations and selected social-psychological attributes which could affect their adoption led to the proposition of hypotheses H_{o3} and H_{o4}.

The following null hypotheses were tested:

H_{o1}: Science opinion leaders who participated in an inservice program dealing with innovative science teaching techniques and materials will adopt no more of the innovations than nonleaders who participated in the same program.

H_{o2}: Teachers from schools which were represented in a science inservice program by science opinion leaders will adopt no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders.

H_{o3}: Scores on the Rokeach Dogmatism Scale are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.

H_{o4}: Scores on the Minnesota Teacher Attitude Inventory are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.

SIGNIFICANCE OF THE STUDY

The American educational system must adapt continuously to keep from falling too far behind the needs and demands of a rapidly evolving society. In the past when cultural change and progress in science were slow, instruction in science could lag fifty years or more with little consequence for the individual or nation;[17] however, rapid changes in science and an exponential growth in scientific information demand the constant adaptation of curriculum practices in science education. The success of the schools' adaptability may be measured by their effectiveness in diffusing innovations to the potential users. Educational programs are not likely to improve unless strategies are developed to diffuse promising new practices to the classroom teacher - the key individual in any successful implementation of new curricula. The idea of diffusion of innovations in education must carry with it the implicit assumption that teachers will learn about and have the opportunity to appraise innovations in an endeavor to create more effective learning experiences for the children they teach. Until strategies are developed to ensure that teachers learn about new ideas and practices and have the opportunity to evaluate their potential, educational change will be too slow to meet the emerging needs of society.

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[17] Paul DeHart Hurd, "Toward a Theory of Science Education Consistent with Modern Science," Theory Into Action (Washington, D.C.: National Science Teachers Association, 1964), p. 7.

Elementary school educators are now confronted with a flood of science innovations. Unfortunately, their potential has not yet been realized. As Lippitt points out:

> Our research is now rich with examples of opportunities provided by nothing gained; with new curricula developed, but lack of meaningful utilization; with new teaching practices invented, but nothing spread; with new richer school environments, but no improvement in the learning experiences of the child.[18]

The task of diffusing the innovations to large numbers of elementary teachers and educating them to make proper and effective use of the new science project materials and techniques will require major commitments of money, time, and effort. If the curriculum reform movements are to contribute to the improvement of science teaching, then strategies must be created to diffuse the innovations to the elementary teachers who will ultimately use them. Action plans are needed to bring the innovations to the attention of the practitioners so that those innovations which should be preserved and those which should not can at least be sorted out.[19] As Smith has insightfully noted concerning the need for diffusion strategies:

> If a fraction of the money that is currently being spent to change educational practices were spent to find out how to succeed in making such changes, a great deal would thereby be saved...Until then, it is likely that we shall continue to waste many man hours in an abortive effort to modify educational practices.[20]

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[18] Ronald Lippitt, "Roles and Processes in Curriculum Development and Change: in Strategy for Curriculum Change, ed. by Kimball Wiles (Washington, D.C.: Association for Supervision and Curriculum Development, 1965), p. 11.

[19] Ibid., p. 17.

[20] B. Othanel Smith, "The Anatomy of Change," Bulletin of the National Association of Secondary School Principals, XXXXVII (May 1963), pp. 9-10.

The identification of key teachers and the concentration of inservice efforts upon them, as proposed in this study, could contribute to the development of strategies for implementing science education innovations more effectively, more economically, and at a more rapid rate.

LIMITATIONS OF THE STUDY

This study was confined to elementary teachers from twenty-nine school systems included in a five-county area in western Pennsylvania. The population included only those elementary classroom teachers who taught in school buildings in which six or more regular classes were conducted. Findings of this investigation were limited to a sample of forty-one teachers, designated by their peers as science opinion leaders or nonleaders, and to the teachers in the schools which they represented. Only elementary teachers who completed the pretest and posttest level of adoption questionnaire were included in the analyses. Any inferences derived from this study are limited by the similarity of the participants to the general population of elementary school teachers.

Data for this investigation consisted of responses to mailed questionnaires administered during January and May of 1969 and of scores on measures of dogmatism and classroom social atmosphere administered during an early March inservice program. Data collected was limited to responses from teachers relevant to level of adoption of selected science curriculum innovations, opinion leadership, dogmatism, and classroom social atmosphere. The study included no assessment of school norms (i.e., traditional vs. modern) concerning predisposition toward change or acceptance of innovations which may have existed prior to the investigation.

The innovations selected for study were limited to ten science investigations from the three major elementary science curriculum projects. Each was selected because it was judged by the writer to exemplify the objectives, techniques, and materials advocated by the developing program. The assumption was made that the teacher could, if he desired, implement any of the ten innovative science investigations as a part of his classroom activity without having to consider administrative approval, cost, or class schedule changes.

REVIEW OF RELATED LITERATURE

Since it was the purpose of this investigation to examine a diffusion strategy, the literature review focuses on studies most relevant to the adoption and spread of innovations. Most studies have necessarily been cited from fields other than education because little evidence is available concerning how innovations spread within schools. The review which follows summarizes the pertinent literature concerning the diffusion strategy explored in this study. Subsections are devoted to the following topics; stages in the adoption of innovations, opinion leadership, dogmatism, and classroom social atmosphere.

Stages in the Adoption of Innovations

The adoption of innovations is conceptualized as a mental process through which an individual passes from first hearing about an innovation to final adoption.[21] The concept appears frequently in diffusion literature and is central to this study, particularly in the development of the questionnaire designed to measure an individual's stage or level of adoption for each of ten innovative science investigations.

The thesis that acceptance of change is a product of a sequence of events operating through time, rather than something that happens all at once, has been recognized by a number of investigators. Ryan and Gross first reported the adoption of a new idea as a multistaged process. In their classic study of hybrid seed corn, they used four stages to describe its acceptance: (1) awareness or first learning about the corn (2) conviction of its usefulness (3) trial acceptance or first use and (4) adoption or 100 per cent use.[22] It was Wilkening who first reported that stages could be applied to an individual's decision to adopt an innovation. He described the adoption of innovations by the individual as

> ...a process composed of learning, deciding, and acting over a period of time. The adoption of a specific practice is not the result of a single decision to act but of a sequence of actions and thought decisions.

The four stages Wilkening listed were: awareness, obtaining information, conviction and trial, and adoption.[23] These stages, with slightly different titles, were highly publicized by a committee of rural sociologists in their bulletin, How Farm People Accept New Ideas.[24] Their five stages of adoption are essentially the same as those described by Rogers and are the ones which were selected for use in this investigation.

Rogers conceptualizes the adoption process in five stages: awareness, interest, evaluation, trial, and adoption. At the awareness stage the individual is exposed to the innovation but lacks complete information about it. He then becomes interested in the innovation and seeks information about it at the interest stage. At the evaluation stage the individual mentally applies the innovation to his present and anticipated future situation, and then decides whether or not to try it. The individual uses the innovation on a small scale in order to determine the utility in his own situation at the trial stage. At the adoption stage the individual decides to continue the full use of the innovation.[25] Evidence from research studies by Copp[26] and Beal[27] indicates the probable validity of the concept of adoption stages.

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[21] Rogers, Diffusion of Innovations, p. 17.

[22] Bryce Ryan and Neal Gross, "The Diffusion of Hybrid Seed Corn in Two Iowa Communities," Rural Sociology, VIII (1943), pp. 15-24.

[23] Eugene A. Wilkening, Adoption of Improved Farm Practices as Related to Family Factors, Research Bulletin No. 183, (Madison, Wisconsin: Experimental Station, 1953).

[24] North Central Rural Sociology Subcommittee for the Study of Diffusion of Farm Practices, How Farm People Accept New Ideas (Ames, Iowa, Agriculture Exptension Service Special Report No. 15, 1955).

Opinion Leadership

Opinion leaders are individuals who exert considerable personal influence because other people seek information from them and because they influence the decisions of others. Rogers described opinion leaders as those individuals in a social system from whom others seek advice and information.[28] Several generalizations concerning opinion leaders have been synthesized from research evidence. Rogers described opinion leadership as a "fairly widespread trait even though it may be concentrated in a few individuals"[29] Others have found opinion leaders and those they influenced to be very much alike. As Katz puts it, "opinion leaders exemplify the values of their followers."[30] Moreover, opinion leaders in one area are not likely to overlap with those in another. For example, in a single, nonspecialized elementary school one teacher may be an opinion leader concerning methods for teaching reading; another one may be an opinion leader in modern mathematics; and still another in the teaching of music. Merton refers to opinion leaders who exert influence only in one rather narrowly defined area as "monomorphic." Those who exert interpersonal influence in a variety of areas, he terms, "polymorphic."[31]

The Measurement of Opinion Leadership

Rogers and Cartano describe the three main techniques for measuring

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25. Rogers, Diffusion of Innovations, p. 119.

26. James H. Copp, "The Function of Information Sources in the Farm Practices Adoption Process," Rural Sociology, XXIII (1957), pp. 146-157.

27. George M. Beal, "Validity of the Concept of Stages in the Adoption Process," Rural Sociology, XXII (1957), pp. 166-168.

28. Rogers, Diffusion of Innovations, p. 208.

29. Rogers, Diffusion of Innovations, p. 226.

30. Elihu Katz, "The Two-Step Flow of Communications: An Up-to-Date Report on a Hypothesis," The Public Opinion Quarterly, XXI, No. 1 (Spring, 1957), p. 77.

31. Robert K. Merton, Social Theory and Social Structure, Revised Edition (Glencoe, Ill.: The Free Press, 1957), p. 414.

opinion leadership as the key informants technique, the self-designating technique, and the sociometric technique.[32] Opinion leaders may be designated by key informants or judges. In this technique, the informants are selected subjectively from the social system as persons likely to know the identity of opinion leaders. For example, a school principal may serve as a key informant in naming a teacher in his school as an opinion leader. The self-designating technique requires a respondent to answer a series of questions which determine the degree to which he perceives himself to be an opinion leader. The advantage of this technique, according to Rogers and Cartano, is that it measures the individual's perception of the opinion leadership situation, which in turn affects his behavior. The sociometric technique consists of asking group members whom they to go for advice and information about an idea. This is the research method most often used in measuring opinion leadership. Rogers and Cartano cite more than a dozen typical studies that have used this method. Because this technique is most applicable to a research design in which all the members of a social system are contacted, it was the technique selected for use in this study. The sociometric technique served as the basis of design for the questionnaire used to determine science opinion leadership among the elementary teachers in each school contacted in this investigation.

Opinion Leadership in the Adoption and Diffusion Processes

The importance of opinion leadership in the adoption and diffusion processes has been demonstrated in many empirical investigations. Findings from studies conducted in rural sociology, medical sociology, and marketing, although not entirely consistent, indicate that individuals designated as opinion leaders adopt innovations earlier than those not so designated. In a relatively early study of opinion leadership, Lionberger surveyed 279 farmers residing in a northeast Missouri community and found that opinion leaders adopted more innovations than nonleaders.[33] Rogers and Havens found a positive relationship between adoption and opinion leaders among a random sample of Ohio truck farmers.[34] Similar findings in medical sociology suggested that physicians who were opinion leaders typically introduced new drugs into their practices much earlier than other doctors. Katz found that doctors who were influential in convincing their colleagues to adopt a new drug were, themselves, relatively earlier adopters of the innovation.[35] Coleman and others studied the diffusion of a new drug among 125 physicians in four midwestern cities. They found that doctors, who maintained a variety of interpersonal contacts with their colleagues and had been designated as opinion leaders from sociometric responses, typically introduced the new drug into their practices months before their colleagues.[36] Several marketing studies also indicated that earlier adopters frequently behave as opinion leaders and inform others about their new products. Bell found that among individuals who purchased innovative products, sixty-five per cent were asked for opinions about their products. Almost half were asked by friends and neighbors to demonstrate the product. Many of the innovators who gave their opinions or demonstrated their product asserted that their questioning friends then purchased the innovation.[37]

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[32] Everett M. Rogers and David G. Cartano, "Methods of Measuring Opinion Leadership," The Public Opinion Quarterly, XXVI (Fall, 1962), pp. 438-439.

[33] Lionberger, "Some Characteristics of Farm Operators," pp. 327-338.

[34] Everett M. Rogers and A. Eugene Havens, Predicting "Innovativeness," Sociological Inquiry, XXXII (1962), pp. 34-42.

[35] Katz, "The Two-Step Flow of Communication," pp. 61-78.

It must be pointed out, however, that a number of findings contradict those just reported. For example, Wilkening found that farmers in a North Carolina community, who had been named as leaders by their peers had not adopted a much higher number of improved farm practices than other farmers.[38] In a sample of Ohio farmers, Havens detected no significant relationship between the time of adoption of bulk milk tanks and opinion leadership.[39] In still another study, Winick reported that physicians, who were designated as opinion leaders, did not adopt new drugs before those not nominated.[40]

Explanations of these apparent contradictory findings have been advanced by several investigators. Chaparro examined new farm practices among Costa Rican farmers and found that conservative leaders tended to lead conservative informal groups, while progressive leaders tended to lead progressive informal groups.[41] Marsh and Coleman investigated adoption of new agricultural practices and found that farmers, in areas favorable to the adoption of new techniques and from whom other farmers obtained information, showed higher rates of adoption than farmers in general; but in areas less favorable to innovations, the adoption rates of leaders were similar to adoption rates of farmers in general.[42]

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[36] James Coleman and others, "Social Processes in Physicians' Adoption of a New Drug," in Social Change, ed. by Amatai and Eva Etzioni, (New York: Basis Books, 1964), p. 454.

[37] William E. Bell, "Consumer Innovators: A Unique Market for Newness," in Toward Scientific Marketing, Proceedings of the Winter Conference of the American Marketing Association, ed. by Stephen A. Greyser, (Boston, Mass., December 27-28, 1962), p. 93.

[38] Eugene A. Wilkening, "Informal Leaders and Innovators in Farm Practices," Rural Sociology, XVII (1952), p. 272.

[39] A. Eugene Havens, "Increasing the Effectiveness of Predicting Innovations," Rural Sociology, XXX (1965), p. 156.

[40] Charles Winick, "The Diffusion of an Innovation Among Physicians in a Large City," Sociometry, XXIV (1961), pp. 384-396.

[41] Alvaro Chaparro, "Role Expectation and Adoption of New Farm Practices," (unpublished Ph.D. thesis, Pennsylvania State University, 1955), p. 185.

[42] C. Paul Marsh and A. Lee Coleman, "Group Influence and Agricultural Innovations: Some Tentative Findings and Hypotheses," American Journal of Sociology, LXI (1956), pp. 588-594.

A generalization concerning the adoption of innovations by opinion leaders has been made by Rogers. Based on evidence gleaned from thirteen research studies in the fields of rural and medical sociology, he reported that "opinion leaders are more innovative than their followers."[43] He was careful to point out, however, that mediating variables such as norms in a given social system may influence the degree to which the generalization holds.

Personal Influence Exerted by Opinion Leaders

Personal influence is defined by Rogers and Beal as a "communication involving a direct face to face exchange between the communicator and the receiver, which results in changed behavior or attitudes on the part of the receiver."[44]

Research interest in the dynamics of personal influence began with the classic 1940 presidential election voting study conducted by Lazarsfeld, Berelson, and Gaudet. On the basis of an ex post facto analysis of interpersonal influence, they found that ideas often flow from radio and print to certain opinion leaders or influentials and then to the less active sections of the population. They discovered that friends, co-workers, and relatives were the most important sources affecting voting decisions. Influence exerted by these individuals was designated "personal influence" and the individuals who influenced others were named "opinion leaders."[45]

Since the 1940 election study, other researchers have examined the significance of opinion leaders in diffusing or spreading innovations. Research in the adoption of new farm practices has generally reflected the important role of personal communication in farmers' adoption decisions. Lionberger found personal influence much more important in the adoption of agricultural innovations than any other communication channel.[46] Similarly, Rahudkar, in his study of India's villages, found that neighbor to neighbor communication was of greater importance in the diffusion of innovations than any other communication channel.[47] Katz and Lazarsfeld found interpersonal communication involved more frequently and had a greater impact than any of the mass media in the switching of brands in small food products, cleansers, and household goods.[48] Menzel, Katz, and Coleman and Menzel and Katz studied the adoption of new drugs by physicians and found interpersonal communication channels to be important sources of information for new drugs, particularly in situations of uncertainty.[49] Whyte studied the ownership of airconditioners in Philadelphia row houses. Although the white collar neighborhoods were very homogenous in terms of age and socioeconomic status, ownership was strongly clustered within neighborhoods rather than evenly distributed throughout the blocks. Whyte attributed the clustering of air-conditioner purchasers to the effect of interpersonal communication.[50] In an educational research study dealing with the advice and information seeking activities of adopters of educational innovations, Carlson found that school superintendents relied heavily on other local superintendents for advice and information concerning modern mathematics.[51]

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[43] Rogers, Diffusion of Innovations, pp. 242-243.

[44] Ibid., pp. 217-218.

[45] Paul F. Lazarsfeld, Bernard Berelson, and Hazel Gaudet, The People's Choice (New York: Duell, Sloan and Pearce, 1944), p. 151.

[46] Herbert F. Lionberger, Sources and Uses of Farm and Home Information by Low Income Farmers in Missouri, Research Bulletin 472 (Columbia, Missouri: Agricultural Experiment Station, 1951).

[47] W. B. Rahudkar, "Impact of Fertilizer Extension Program on the Minds of the Farmers and Their Reactions to Different Extension Methods," Indian Journal of Agronomy, III (1958), pp. 119-136.

The evidence cited suggests that advice and information sought from peers, or other persons in the same occupation in the same locality, play a major role in the decision to adopt innovations, the apparent reason being that such advice involves personal influence.[52] An individual who is more innovative than his peers is certainly in a position to influence their adoption decisions because of his prior experience with the innovation. Rogers calls this the "interaction effect" and describes it as "a process through which individuals in a social system who have adopted an innovation influence those who have not yet adopted."[53] Ryan and Gross, in what has become the classic study of diffusion in rural sociology, analyzed the diffusion of hybrid seed corn among 259 Iowa farmers and first described this "snowball" or "chain reaction" effect:

> There is no doubt but that the behavior of one individual in an interacting population affects the behavior of his fellows. Thus, the demonstration success of hybrid seed on a few farms offers a changed situation to those who have not been so experimental. The very fact of acceptance by one or more farmers offered new stimulus to the remaining ones.[54]

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[48] Elihu Katz and Paul Lazarsfeld, Personal Influence (Glencoe, Illinois: Free Press, 1955).

[49] Herbert Menzel and Elihu Katz, "Social Relations and Innovations in the Medical Profession: The Epidemiology of a New Drug," Public Opinion Quarterly, XIX (1955), pp. 337-352; James Coleman, Herbert Menzel, and Elihu Katz, "The Diffusion of an Innovation," Sociometry, XX (1957), pp. 253-270.

[50] William H. Whyte, Jr., "The Web of Word of Mouth," Fortune, L November, 1954), pp. 140-144.

[51] Richard O. Carlson, Adoption of Educational Innovations. (Eugene, Oregon: University of Oregon, 1965).

[52] Ibid., p. 39.

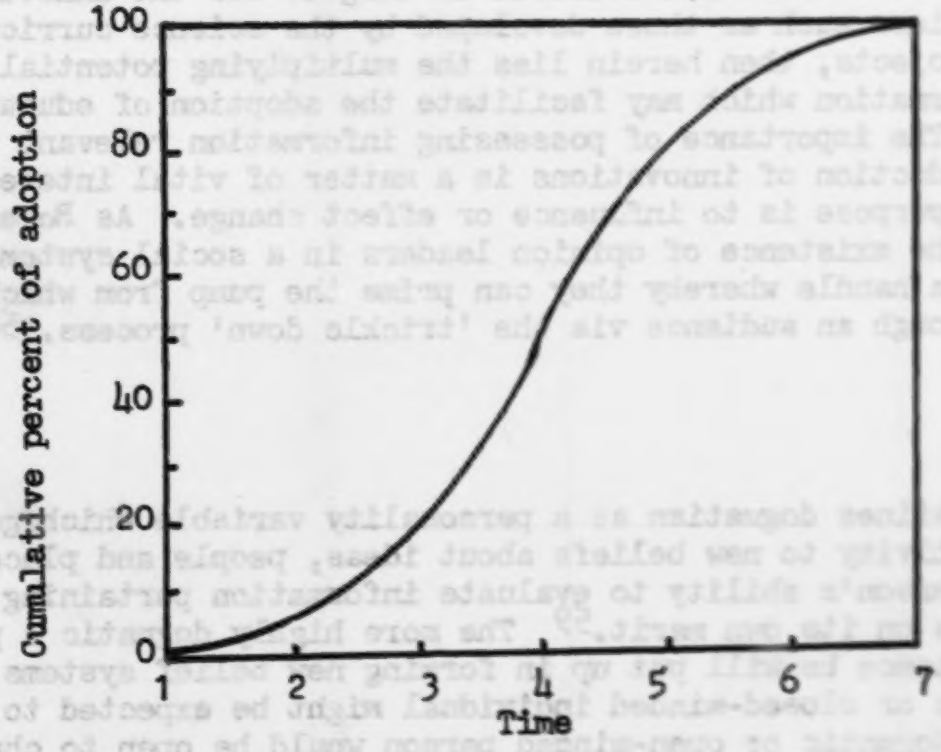
[53] Rogers, Diffusion of Innovations, p. 215.

[54] Ryan and Gross, "The Diffusion of Hybrid Seed Corn," p. 23.

Researchers have also noted that the growth in the number of users of an innovation can be approximated by an S-shaped curve. When the cumulative percentage of adopters of innovations is graphed from the time of its first acceptance until it is completely diffused, the curve produced has a shape similar to that shown in Figure 1.[55]

FIGURE 1

THE NORMAL DIFFUSION CURVE



If, as the diffusion curve suggests, there is intercommunication among adopters and the act of adoption by some acceptors is itself a means of influencing others to adopt a practice, then it might be expected that the adoption of science curriculum innovations by science opinion leaders may, indeed, be a mechanism for diffusing the innovations within a school.

Research related to the role of school opinion leaders in the adoption of innovations has been neglected. Carlson, in describing needed research on the diffusion of educational innovations, suggested that "the extent to which local opinion leaders have uniform influence on all potential adopters in a given locality is a matter of prime concern for those who wish to engineer change."[56] In a later paper concerning adoption and diffusion of educational innovations delivered at the 1968 National Conference on the Diffusion of Educational Innovations, Carlson noted that the problem of diffusion of innovations within a school system has been ignored and that a large gap in knowledge concerning educational innovations will continue to exist"...until attention is given to who plays what part within a school system."[57]

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[55] Carlson, Adoption of Educational Innovations, pp. 5-10.

[56] Richard O. Carlson, "Strategies for Educational Change: Some Needed Research on the Diffusion of Innovations" (paper presented at the Conference on Strategies for Educational Change, U. S. Office of Education, Washington, D.C., 1965), p. 8.

Research attention should be directed to individuals from whom others seek advice and information about school matters. Evidence cited previously indicates that some persons have more influence than others, adopt innovations earlier than others, and that their knowledge and advice are likely to be sought by and shared with others. If such persons can be identified and utilized as targets for the innovational input of practices such as those developed by the science curriculum development projects, then herein lies the multiplying potential for diffusing information which may facilitate the adoption of educational innovations. The importance of possessing information relevant to the point of introduction of innovations is a matter of vital interest for persons whose purpose is to influence or effect change. As Rogers points out, "the existence of opinion leaders in a social system offers change agents a handle whereby they can prime the pump from which new ideas flow through an audience via the 'trickle down' process."[58]

Dogmatism

Rokeach defines dogmatism as a personality variable which governs a person's receptivity to new beliefs about ideas, people and places, and includes the person's ability to evaluate information pertaining to each of these topics on its own merit.[59] The more highly dogmatic a person is, the more resistance he will put up in forming new belief systems. The highly dogmatic or closed-minded individual might be expected to resist change while the low dogmatic or open-minded person would be open to change.

The basic assumptions in Rokeach's theory suggest that since low dogmatics use more sources for obtaining information and are more likely to be among the first to be aware of innovations, they are, therefore, more likely to be among the first to adopt innovations. In addition to being more prone to change, the low dogmatic is less dependent upon authority decisions to use or not to use innovations, and therefore, may be more inclined to act on his own initiative in decisions concerning the adoption of innovations.[60]

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57. Richard O. Carlson, "Summary and Critique of Educational Diffusion Research" (paper presented at the National Conference on the Diffusion of Educational Ideas, East Lansing, Michigan, March 26-28, 1968), p. 10.

58. Rogers, Diffusion of Innovations, pp. 281-282.

59. Rokeach, The Open and Closed Mind, p. 73.

60. Ibid., pp. 60-64.

An analysis of past diffusion research revealed only a few studies which concerned the relationship between dogmatism and the adoption of innovations. In a study which examined the process of innovation by teachers in three Michigan high schools, Lin found that the more generally predisposed teachers were to accepting change and innovation in the school, the more likely they were to be low dogmatics.[61] Conversely, in a study of sixteen elementary teachers, Raack found a significant positive correlation between dogmatism and desire or ability on the part of the more dogmatic teachers to increase their use of a new teaching technique.[62] Childs investigated the relationship between the belief systems of administrators and teachers in innovative and noninnovative school districts. Correlating dogmatism and innovativeness, he found a negative relationship between innovation and the number of individuals exhibiting dogmatism.[63]

In rural sociology, Rogers analyzed the personality characteristics of 23 Iowa farm operators and found that the early adopters scored lower on the dogmatism scale than the less innovative farmers.[64] Jamias, studying the adoptive behavior of 147 Michigan dairy farmers, found that highly dogmatic farmers had a lower adoption rate than less dogmatic farmers.[65]

The evidence cited supports the proposition that dogmatism may affect the adoption of science curriculum innovations by elementary teachers. If a relationship exists between the degree of dogmatism and change in the level of adoption of innovations, then a measure of dogmatism may be used to identify individual teachers upon whom change agents could concentrate their efforts with a better than even chance for successful reception.

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[61] Nan Lin and others, The Diffusion of an Innovation in Three Michigan High Schools: Institution Building Through Change (Project on the Diffusion of Educational Practices in Thailand, Research Report Number 1, Department of Communication, Michigan State University, East Lansing, Michigan, December, 1966), p. 2.

[62] Marilyn L. Raack, "The Effect of an In-service Education Program on Teacher Verbal Behavior" (unpublished Ed.D. Thesis, University of California, Los Angeles, 1967).

[63] John W. Childs, "A Study of the Belief Systems of Administrators and Teachers in Innovative and non-Innovative School Districts" (unpublished Ph.D. Thesis, Michigan State University, East Lansing, Michigan, 1965), p. 50.

[64] Everett M. Rogers, "Personality Correlates of the Adoption of Technological Practices," Rural Sociology, XXII (September, 1957), p. 268.

[65] Juan F. Jamias, "The Effects of Belief System Styles on the Communication and Adoption of Farm Practices" (unpublished Ph.D. Thesis, Michigan State University, East Lansing, Michigan, 1964), p. 78.

Classroom Social Atmosphere

The elementary science curriculum development projects have shifted the emphasis of science teaching from the textbook memorization of science content in teacher-dominated classrooms to student-centered experiences stressing the processes of science. Teacher adoption of the innovative techniques and materials necessitates a reasonably permissive classroom atmosphere in which children have the freedom to explore, to cooperate, to converse, to try and to fail. The teacher's role in an innovative program is described most cogently by Kageyama, who served the Science Curriculum Improvement Study as a demonstration teacher.

> Pupils are allowed to discover rather than cover science. The teacher is no longer the dominant figure, and the only source of information. Her role is to create an environment that invites and supports curiosity, investigation, and inquiry. In this program, teaching is listening to the children as they talk to one another and not to be the teacher. The teacher guides but does not dominate. The strategy is to promote learning by promoting interaction among children.[66]

All of the projects emphasize pupil experiences such as independent study, laboratory investigations, discussion groups, and experimentation with materials interesting to the children. The Elementary Science Study describes its program as "one in which all children have access to the materials for open-ended rather than teacher or textbook directed investigations."[67] Similarly, in the Science Curriculum Improvement Study program, "children learn science in an intellectually free atmosphere where their own ideas are respected, where they learn to test their ideas, not on the basis of some authority, but on the basis of their own observations."[68] Livermore, describing the intentions of the writers of Science-A Process Approach, said that the primary aim of the program was

> ...to develop the child's skills in using science processes. Skills cannot be developed by reading about science. For this reason, the exercises were written as instructions for teachers, not as reading material for children. Each activity described a variety of activities which the children would do, either individually or in small groups. Demonstrations

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[66] Christina Kageyama, "From Foreground to Background: The Changing Role of the Teacher," Newsletter, Science Curriculum Improvement Study, No. 9 (Winter, 1967), pp. 2-4.

[67] Lockard, Sixth Report of the International Clearinghouse, p. 220.

[68] *Ibid.*, p. 332.

by the teacher were avoided as much as possible.[69]

Although little empirical evidence is available regarding the methods and techniques actually used by elementary teachers to teach science, several widely recognized viewpoints are that elementary science is taught primarily by textbook reading, lecturing, recitation or demonstration; that classes are teacher-centered; and that textbook subject-matter is covered with little regard for children's needs. In a survey of elementary science in 214 school systems in western Pennsylvania, Sloppy collected evidence which generally supports these viewpoints. He found that the method of teaching elementary science which received the highest response was textbook reading, discussion and demonstration (80.8 per cent) while inquiry and student-centered techniques ranked fifth and sixth (44.4 and 37.4 per cent, respectively) of eight choices. In a question asking how the schools would classify the majority of pupil experiences, teacher demonstration received 55.6 per cent of the total responses, whereas, inquiry-type investigations received 33.6 per cent of the total responses and child-oriented experiments received 32.2 per cent.[70]

Goodlad, in a recent visit to more than 250 schools across the nation, logged the characteristic classroom practices he saw. Instruction was characterized by much talking by the teacher, much drill on specific facts, and dominated by the textbook. As he put it, "It would seem that a substantial part of whatever thrust there has been in recent efforts to change schools have been blunted on the classroom door."[71]

The adoption of new science curriculum techniques and materials would, for many teachers, necessitate a change in the type of social atmosphere maintained during the teaching of science. Adoption would require a shift from teacher-dominated techniques to student-centered techniques, from teacher lecture and demonstration to student investigation, and from subject-matter chosen by the textbook to subject-matter selected cooperatively by pupils and teachers. As Brandwein asserted, the teacher must be freed "...from the need to cover a text or a syllabus by telling, telling, and more telling."[72]

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[69] Arthur H. Livermore, "The Process Approach of the AAAS Commission on Science Education," Journal of Research in Science Teaching, II, 4 (1964), p. 272.

[70] Harold Littell Sloppy, "A Survey of Elementary Science in Western Pennsylvania" (unpublished M.Ed. Research Project, Indiana University of Pennsylvania, Indiana, Pennsylvania, 1968), pp. 39-42.

[71] John I. Goodlad, "Educational Change: A Strategy for Study and Action," The National Elementary Principal, XLVIII, 3 (January, 1969), p. 8.

[72] Paul F. Brandwein, "Elements in a Strategy for Teaching Science in the Elementary School," The Teaching of Science (Cambridge, Massachusetts: Harvard University Press, 1962), p. 119.

It can be argued that the adoption of new science curriculum practices is dependent upon the type of social atmosphere established by teachers. Teachers who are predisposed to provide or who are now providing experiences in which pupils have the freedom to explore, to cooperate, and to enjoy science are operating within a social atmosphere compatible with that proposed by the science curriculum projects; and therefore, might readily adopt science project innovations. On the other hand, teachers who are predisposed to maintain or who are now maintaining classrooms which are dominated by the teacher and lack opportunities for pupils to discover and exchange ideas are operating within a social atmosphere incompatible with that proposed by the science curriculum projects; and therefore, would be less likely to adopt the science curriculum innovations.

Rogers defines compatibility as the "degree to which an innovation is consistent with existing values and past experiences of the adopters."[73] An innovation that is not compatible with the classroom social atmosphere maintained by a teacher may not be adopted so readily as an innovation that is compatible.

One facet of this investigation is designed to determine if teacher performance on the Minnesota Teacher Attitude Inventory (MTAI) is significantly related to his adoption of selected science teaching innovations and techniques. The MTAI was developed as a predictor of the type of social atmosphere a teacher will maintain in the classroom or of "...those attitudes of a teacher which predict how well she will get along with pupils in interpersonal relationships."[74] Validation studies by Cook, Leeds, and Callis; Stein and Hardy; and Leeds attest to the value of the MTAI for this type of prediction with experienced teachers.[75]

Those teachers who rank high on the MTAI are expected to be capable of establishing cooperative and mutual relationships with their students; those who rank low are likely to be more dominating and authoritative in their behavior. These low-scoring teachers would also be more subject-and-self oriented than the high scoring teachers, who should be more concerned with the pupils themselves and their participation in classroom experiences. If it can be demonstrated that the MTAI is not only an index of classroom social atmosphere but also an index of adoption of new science teaching practices, then the predictive uses of the instrument can be extended.

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[73] Rogers, Diffusion of Innovations, p. 127.

[74] W. W. Cook, C. H. Leeds, and R. Callis, Minnesota Teacher Attitude Inventory (New York: The Psychological Corporation, 1951).

[75] Cook, Leeds, and Callis, Minnesota Teacher Attitude Inventory: H. L. Stein and J. Hardy, "A Validation Study of the Minnesota Teacher Attitude Inventory in Manitoba," Journal of Educational Research, L (January, 1957), pp. 321-338; C. H. Leeds, "Predictive Validity of the Minnesota Teacher Attitude Inventory," The Journal of Teacher Education, XX (Spring, 1969), pp. 51-56.

METHODS

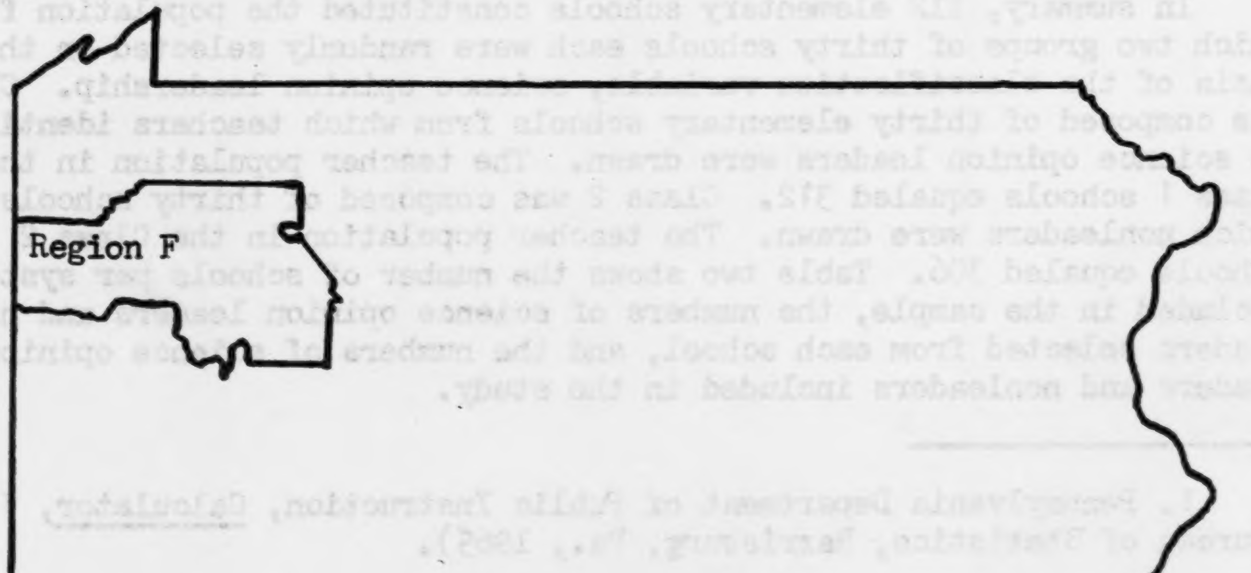
The purpose of this section is to describe the procedures employed in the diffusion strategy examined in this study. The following subsections are included; the population, selection of the samples, the instruments, the Science Inservice Program, collection of data and methods of data analyses.

The Population

Subjects from which data were collected for this investigation came from a population comprised of elementary classroom teachers from 112 elementary schools in western Pennsylvania. The schools are located in an area officially designated by the Pennsylvania Department of Education as Region F. Clarion State College serves Region F as the coordinating center for regional planning and curriculum improvement. The five counties included in the region are: Clarion, Forest, Jefferson, Mercer, and Venango. The location of these counties in Pennsylvania is shown in Figure 2, the Pennsylvania Region F Outline Map.

FIGURE 2

PENNSYLVANIA - REGION F OUTLINE MAP



The region is sparsely populated, predominantly rural, and nonfarm. It is an economically depressed part of Appalachia, in a long range decline since World War II. It included twenty-nine school systems and approximately 75,000 elementary and secondary students.[1]

The population in this study was limited to the 1,205 elementary classroom teachers in the twenty-nine school systems in Region F who taught in school buildings in which six or more regular elementary classes were conducted. Included were classroom teachers of kindergarten through grade six. Excluded were teachers in such specialized areas as special education, reading, and speech pathology. Table one, shown on the next page, lists the school systems, addresses, and numbers of elementary schools and teachers included in the population.

SELECTION OF THE SAMPLES

All elementary classroom teachers in elementary schools having six or more regular classes, identified from information provided by school administrators in Region F. constituted the population. A total of 112 schools met the defined criteria and were assigned numbers ranging from 001 to 112. The schools from which the samples were drawn were selected from a table of random numbers compiled by Clark.[2] In accordance with procedures for assigning classification variables as outlined by Ferguson,[3] sixty schools were selected on the basis of the classification variable, science opinion leadership. The first thirty schools chosen from the table of random numbers were designated Class 1 schools. Class 1 schools were schools from which elementary teachers, identified by their peers as science opinion leaders, were drawn for participation in the Science Inservice Program. The next thirty schools chosen from the table of random numbers were designated Class 2 schools. Class 2 schools were schools from which elementary teachers, identified by their peers as nonleaders, were drawn for participation in the Science Inservice Program.

In summary, 112 elementary schools constituted the population from which two groups of thirty schools each were randomly selected on the basis of the classification variable, science opinion leadership. Class 1 was composed of thirty elementary schools from which teachers identified as science opinion leaders were drawn. The teacher population in the Class 1 schools equaled 312. Class 2 was composed of thirty schools from which nonleaders were drawn. The teacher population in the Class 2 schools equaled 306. Table two shows the number of schools per system included in the sample, the numbers of science opinion leaders and nonleaders selected from each school, and the numbers of science opinion leaders and nonleaders included in the study.

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[1] Pennsylvania Department of Public Instruction, Calculator, V (Bureau of Statistics, Harrisburg, Pa., 1965).

[2] Charles E. Clark, Random Numbers in Uniform and Normal Distribution (San Francisco: Chandler Publishing Company, 1966), pp. 7-64.

[3] George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Company, 1966), pp. 278-280.

TABLE 1

NUMBER OF ELEMENTARY SCHOOLS AND TEACHERS IN EACH SCHOOL SYSTEM IN THE POPULATION

School System	Address	Number of Elementary Schools in the Population	Number of Elementary Teachers Included in the Population
Allegheny-Clarion Valley	Foxburg	4	34
Brockway Area	Brockway	2	26
Brookville Area	Brookville	4	36
Clarion Area	Clarion	2	27
Clarion-Limestone	Strattanville	2	20
Commodore-Perry	Hadley	1	12
Cranberry Area	Seneca	6	44
Dubois Area	Dubois	12	109
Farrell Area	Farrell	5	51
Forest Area	Tionesta	3	23
Franklin Area	Franklin	6	76
Greenville Area	Greenville	3	42
Grove City	Grove City	6	58
Hickory Township	Sharon	3	52
Jamestown Area	Jamestown	1	9
Keystone	Knox	3	27
Lakeview	Stoneboro	3	29
Mercer	Mercer	2	40
North Clarion County	Tylersburg	1	12
Oil City Area	Oil City	9	84
Pleasantville Joint	Pleasantville	1	12
Punxsutawney Area	Punxsutawney	10	82
Redbank Valley	New Bethlehem	5	41
Reynolds	Greenville	3	37
Sharon	Sharon	6	86
Sharpsville Area	Sharpsville	3	40
Union	Rimersburg	2	26
Valley Grove	Franklin	3	36
West Middlesex Area	West Middlesex	1	34
Total		112	1205

TABLE 2

NUMBER OF SCHOOLS PER SYSTEM FROM WHICH SAMPLES WERE DRAWN; NUMBER OF ELEMENTARY TEACHERS PER SYSTEM INCLUDED IN THE SAMPLE; NUMBER OF SCIENCE OPINION LEADERS AND NONLEADERS SELECTED FROM EACH SCHOOL; AND THE NUMBER OF SCIENCE OPINION LEADERS AND NONLEADERS INCLUDED IN THE STUDY

School System	Number of Schools From Which Samples Were Drawn	Number of Teachers Included in the Sample	Number of Science Opinion Leaders Selected	Number of Science Opinion Leaders Included in the Study	Number of Nonleaders Selected	Number of Nonleaders Included in the Study
Allegheny-Clarion Valley	2	21	1	1	1	1
Brockway Area	2	27	1	0	1	1
Brookville Area	2	14	1	1	1	1
Clarion Area	1	7	1	1	0	0
Clarion-Limestone	1	14	1	1	0	0
Commodore Perry	1	12	0	0	1	1
Cranberry Area	2	12	1	1	1	1
Dubois Area	5	53	4	1	1	1
Farrell Area	2	13	1	1	1	0
Forest Area	3	23	1	1	2	2
Franklin Area	4	55	1	0	3	2
Greenville Area	3	42	1	0	2	0

TABLE 2 (Con'd)

Grove City	2	22	1	1	1	1
Hickory Township	0	0	0	0	0	0
Jamestown Area	1	9	1	0	0	0
Keystone	2	14	1	1	1	1
Lakeview	2	17	0	0	2	0
Mercer	0	0	0	0	0	0
North Clarion County	1	12	0	0	1	1
Oil City Area	7	55	3	2	4	3
Pleasantville	0	0	0	0	0	0
Punxsutawney Area	4	27	0	0	4	3
Redbank Valley	3	28	2	2	1	1
Reynolds	1	13	1	0	0	0
Sharon	3	53	2	1	1	0
Sharpsville Area	2	30	2	2	0	0
Union	2	26	2	2	0	0
Valley Grove	2	19	1	1	1	1
West Middlesex Area	0	0	0	0	0	0
Total	60	618	30	20	30	21

All 618 teachers in the sixty schools (Class 1 and Class 2) received the pretest level of adoption questionnaire, Part I, and the school specific, sociometric measure of science opinion leadership, Part II. Only the science opinion leaders and nonleaders who participated in the Science Inservice Program completed measures of dogmatism and classroom social atmosphere. All teachers who completed the pretest level of adoption questionnaire, Part I received the posttest level of adoption questionnaire, Part I. Each of these instruments is described in detail in the next subsection.

THE INSTRUMENTS

The instruments utilized in this investigation consisted of a two-part questionnaire developed by the investigator and measures of dogmatism and classroom social atmosphere. The pretest level of adoption questionnaire, Part I, and the sociometric measure of opinion leadership, Part II were administered to all 618 teachers in both Class 1 and Class 2 schools prior to inviting thirty science opinion leaders and thirty nonleaders to participate in the Science Inservice Program. Part I of the questionnaire was again administered as a posttest to all teachers in the Class 1 and Class 2 schools ten weeks after the final Science Inservice Program session. The data concerning change in level of adoption, which was derived by subtracting pretest scores from posttest scores, were used to test hypotheses H_{o1} and H_{o2}. The Rokeach Dogmatism Scale and the Minnesota Teacher Attitude Inventory were administered to the participating science opinion leaders and nonleaders during the first two hours of the Science Inservice Program. The data from the measures were used to test hypotheses H_{o3} and H_{o4}.

The following subsections describe: Part I of the questionnaire which measured teacher level of adoption of ten innovative science investigations; Part II of the questionnaire which identified science opinion leaders and nonleaders in each of the sixty schools; the Rokeach Dogmatism Scale which measured dogmatism and the Minnesota Teacher Attitude Inventory which measured classroom social atmosphere.

Questionnaire, Part I

A measure of teacher level of adoption of selected innovative elementary science investigations was obtained by Part I of a questionnaire developed by the investigator. Adoption-process theory was the basis for the design of the instrument. Investigators contend that adoption of any practice is a process with identifiable stages conceptually classified as (1) awareness, (2) interest, (3) evaluation, (4) trial, and (5) adoption. The five adoption levels were incorporated into the following seven-point scale which was used to identify the level of adoption that teachers had reached for each of ten innovative elementary science investigations. The following scale was revised and adapted from an earlier scale by Miller.[4]

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[4] Texton R. Miller, Teacher Adoption of a New Concert of Supervised Practice in Agriculture, Educational Research Series, No. 4 (Department of Agricultural Education, North Carolina State University, Raleigh, North Carolina, 1965), p. 5.

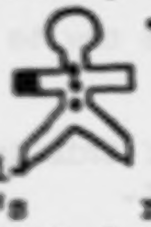
Adoption Scale

Score No. 1	This investigation is new to me; I hadn't heard of it before.
Score No. 2	I've heard or read of this investigation, but I haven't given it much thought.
Score No. 3	I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
Score No. 4	I doubt that this investigation would be of much value to me in my teaching situation.
Score No. 5	This investigation looks promising for my teaching situation, but I haven't tried it yet.
Score No. 6	I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
Score No. 7	I have used or am using this investigation in my classroom and I intend to use it again in the future.

The scores on the adoption scale corresponded to the stages or levels of adoption. Scores of "one" and "two" related to the awareness of the investigation. Two scores were included for this stage to compensate for the awareness of the investigation created by its description on the pretest. A score of "three" was equivalent to the interest stage. Since the investigations may be evaluated unfavorably or favorably, the scores "four" or "five" were used to indicate that either unfavorable or favorable evaluation had occured. Score "six" indicated a teacher in the trial stage of adoption and score "seven" indicated complete teacher adoption of the investigation.

The level of adoption questionnaire, Part I described each investigation, A through J.[5] Following each description, the respondent was requested to circle the number corresponding to one of the seven statements of the adoption scale which best described his present feeling about and/or use of the investigation. The following description of investigation A, synthesized from the Science Curriculum Improvement Study book Relativity,[6] is presented as an example.

Description of Investigation A

This investigation concerns relativity or the positions and motions of objects relative to other objects. It involves the use of an artificial observer, Mr. O., who is made of paper and is shaped like this . For the children, Mr. O becomes a central reference object. The position of any object either at rest or in motion is described relative to Mr. O. Children are involved in individual or group activities such as discussing Mr. O's relative position, cutting out Mr. O figures, and manipulating Mr. O's position relative to other objects.

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[5] For a specific description of each of the ten science investigations A through J, the reader is referred to Part I of the questionnaire located in the appendixes.

[6] Science Curriculum Improvement Study, Relativity (Lexington, Massachusetts: D.C. Heath and Company, 1968).

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present
1 2 3 4 5 6 7 feeling about and/or use of Investigation A.[7]

Scores on the adoption scale were converted to level of adoption scores by the conversion scale shown in Table Three.

TABLE 3

ADOPTION SCALE SCORES CONVERTED TO LEVEL OF ADOPTION SCORES

Adoption Scale Score Number		Level of Adoption		Score
1,2	=	Awareness	=	1
3	=	Interest	=	2
4,5	=	Evaluation	=	3
6	=	Trial	=	4
7	=	Adoption	=	5

A level of adoption score was tabulated for each respondent by summing the scores for each of the ten investigations. The possible range in individual level of adoption scores is from ten to fifty.

Part I, the level of adoption questionnaire, was administered as a pretest-posttest. To determine the questionnaire's reliability it was administered to a sample of ninety-four teachers in thirteen schools in Region F. The teachers included in this sample were not represented in the inservice program. After a delay of four months, the same questionnaire was again administered to the same sample. The product-moment r was computed and used as an estimate of reliability. The coefficient of correlation was established at r equals .65.

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[7] For the respondent's reference, the seven statements included in the adoption scale were located at the top of each page of the questionnaire.

Part I of the questionnaire was administered by mail during January 1969 to all elementary teachers in the sixty schools designated as Class 1 and Class 2. The first administration, the pretest, determined the level of adoption of the ten investigations for all responding teachers. The posttest was administered during May 1969, ten weeks after the completion of the Science Inservice Program. Change in level of adoption was determined by subtracting, algebraically, pretest scores from posttest scores.

Computation of the change scores provided the data necessary to test the null hypothesis H_{o1}: science opinion leaders who participated in an inservice program dealing with innovative science teaching techniques and materials will adopt no more of the innovations than nonleaders who participated in the same program.

Calculating the change in level of adoption scores for all teachers in the sampled schools, excluding science opinion leaders and nonleaders who participated in the inservice program, provided the data necessary to test the null hypothesis H_{o2}: teachers in schools which were represented in a science inservice program by science opinion leaders will adopt no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders. The differential change in level of adoption between teachers in Class 1 schools and teachers in Class 2 schools provided an index of diffusion or a measure of the extent to which the innovations spread within the schools represented by science opinion leaders and those represented by nonleaders.

Calculation of the change scores also provided the data necessary for testing the correlation between change in level of adoption and the Science Inservice Program participants' scores on measures of dogmatism and classroom social atmosphere.

Sociometric Measure of Science Opinion Leadership, Part II

Part II of the questionnaire is a sociometric technique used to measure science opinion leadership. A school-specific roster of teachers was prepared for each of the sixty individual schools in Class 1 and 2. Each teacher was presented with a roster for his respective school only. He was requested to indicate by numbers 1, 2, and 3 the teachers from whom he would seek advice and information about newly developed science teaching methods and materials. The questionnaire was structured as follows:

> Assume that you are interested in obtaining advice or information about newly developed methods and materials for teaching science in your elementary school. From the list of names below, select the individuals to whom you would go for such science teaching advice or information.
>
> Directions: Place a 1 beside the name of the individual to whom you would go first.
> Place a 2 beside the name of the individual to whom you would go second.
> Place a 3 beside the name of the individual to whom you would go third.
>
> ______Mr. William Chamberlain

________Mrs. Mary K. Hobaugh

________Mrs. Emily Bower

________Mrs. Henrietta Kodrich

________Mrs. James Donachy

________Mrs. George Harmon

________Mr. Gil Twiest

This technique for measuring opinion leadership was chosen because it is most applicable to a research design in which all members of a particular group are surveyed. Rogers describes this sociometric method as the one most often used in past research and cites more than fifteen studies which have utilized it.[8]

Part II of the questionnaire was administered by mail jointly with Part I during January 1969 to all elementary teachers in the sixty schools designated as Class 1 and Class 2. A responding teacher indicated his relative choices for science opinion leader by marking scores 1, 2, and 3 beside selected names on his school roster. All other teachers on the roster for whom he did not mark a score were assigned a score of 4. The individual teacher in each elementary school in Class 1 who received the lowest score determined by summing the scores for each individual teacher was designated science opinion leader for that school. In each elementary school in Class 2 the individual who received the highest score was designated nonleader. In cases where two or more individuals in any school attained the same score for either science opinion leader or nonleader, the individual who was invited to participate in the Science Inservice Program was chosen randomly. A sample copy of the questionnaire, Parts I and II, appears in the appendixes.

Rokeach Dogmatism Scale

The Rokeach Dogmatism Scale, Form E, was used to measure dogmatism. It was administered to the science opinion leaders from the Class 1 schools and the nonleaders from the Class 2 schools during the first hours of the Science Inservice Program session. A sample of the Dogmatism Scale, Form E is included in the appendixes.

The elementary teachers indicated disagreement or agreement with each of the forty items on a scale ranging from minus three to plus three with the zero point excluded in order to force responses toward disagreement or agreement. This scale was converted, for scoring purposes, to a 1-to-7 scale by adding a constant of four to each item score. The total is the sum of scores obtained on all items in the test. Scores may range from 40 to 280.

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[8] Rogers, Diffusion of Innovations, pp. 228-229.

Rokeach reports that the reliabilities of the Dogmatism Scale, Form E, range from .68 to .93.[9] Table four shows the groups to which the Scale was administered, the numbers of cases, the reliabilities, the means, and the standard deviations.

Dogmatism scores were obtained for each Science Inservice Program participant. The data obtained were used to test the null hypothesis H_{o3}: scores on the Rokeach Dogmatism Scale are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.

TABLE 4

RELIABILITIES, MEANS, AND STANDARD DEVIATIONS OF DOGMATISM SCALE, FORM E[10]

Number of Items	Group	Number of Cases	Reliability	Mean	Standard Deviation
40	English Colleges	80	.81	152.8	26.2
	English Workers	60	.78	175.8	26.0
	Ohio State U. I	22	.85	142.6	27.6
	Ohio State U. II	28	.74	143.8	22.1
	Ohio State U. III	21	.74	142.6	23.3
	Ohio State U. IV	29	.68	141.5	27.8
	Ohio State U. V	58	.71	141.3	28.2
	Mich. State U. IV	89	.78	-	-
	VA domiciliary	80	-	183.2	26.6
		24	.93	-	-
		17	.84	-	-

Minnesota Teacher Attitude Inventory

The Minnesota Teacher Attitude Inventory (MTAI) was used to determine the type of social atmosphere or teacher-pupil relations a teacher maintains in the classroom. Its value for this type of prediction has been validated by several authors including Cook, Leeds, and Callis[11] and Stein and Hardy.[12]

Cook, Leeds, and Callis, the authors of the Inventory, describe the characteristics of desirable and undesirable teacher-pupil relations. A desirable social relationship is described as follows:

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[9] Rokeach, The Open and Closed Mind, pp. 89-91.

[10] Ibid.

[11] Cook, Leeds, and Callis, Minnesota Teacher Attitude Inventory, pp. 13-14.

[12] Stein and Hardy, A Validation Study of the MTAI, pp. 321-338.

> It is assumed that a teacher ranking at the high end of the scale should be able to maintain a state of harmonious relations with his pupils characterized by mutual affection and sympathetic understanding. The pupils should like the teacher and enjoy school work. The teacher should like the children and enjoy teaching. Situations requiring disciplinary action should rarely occur. The teacher and pupils should work together in a social atmosphere of cooperative endeavor, of intense interest in the work of the day, and with a feeling of security growing from a permissive atmosphere of freedom to think, act and speak one's mind with mutual respect for the feelings, rights and abilities of others. Inadequacies and shortcomings in both teacher and pupils should be admitted frankly as something to overcome, not ridicule. Abilities and strengths should be recognized and used to the utmost for the benefit of the group. A sense of proportion involving humor, justice and honesty is essential. Group solidarity resulting from common goals common understanding, common efforts, common difficulties, and common achievements should characterize the class.

An undesirable social relationship is described as follows:

> At the other extreme of the scale is the teacher who attempts to dominate the classroom. He may be successful and rule with an iron hand, creating an atmosphere of tension, fear and submission; or he may be unsuccessful and become nervous, fearful and distraught in a classroom characterized by frustration, restlessness, inattention, lack of respect, and numerous disciplinary problems. In either case both teacher and pupils dislike school work; there is a feeling of mutual distrust and hostility. Both teacher and pupils attempt to hide their inadequacies from each other. Ridicule, sarcasm and sharp-tempered remarks are common. The teacher tends to think in terms of his status, the correctness of the position he takes on classroom matters, and the subject matter to be covered rather than in terms of what the pupils needs, feels, knows, and can do.[13]

The MTAI consists of 150 items. There are five possible answers for each item. These are: strongly agree (SA), agree (A), undecided (U), disagree (D), and strongly disagree (SD). The possible range of scores on the MTAI is from plus 150 to minus 150. According to criteria established by the authors, each response in accordance with a positive attitude statement has a value of plus one and each response in accordance with a negative attitude statement has a value of minus one. For purposes of scoring, this scale was converted to a zero to 300 scale by adding a constant of 150 to each final score. The instrument may be obtained from the Psychological Corporation, 304 East 45th Street, New York, N.Y.

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[13] Cook, Leeds, and Callis, Minnesota Teacher Attitude Inventory, p. 3.

Two predictive validity coefficients were computed for Form A, MTAI. On the basis of three criteria; rating of teachers by their peers, rating of teachers by their principals, and rating of teachers by a specialist in the area of teaching effectiveness, the coefficients were established at r equals .59 and R equals .63.[14] Norms have been established for experienced teachers. Those for elementary teachers may be seen in Table five.

Scores on the MTAI were obtained for each Science Inservice Program participant. The data obtained were used to test the null hypothesis H_{o4}: scores on the Minnesota Teacher Attitude Inventory are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.

The MTAI and the Rokeach Dogmatism Scale were both administered to participants in the Science Inservice Program which is described in the next subsection.

THE SCIENCE INSERVICE PROGRAM

Sixty elementary teachers, thirty science opinion leaders from the Class 1 schools and thirty nonleaders from the Class 2 schools, were invited to a Science Inservice Program jointly sponsored by the U.S. Office of Education and Clarion State College. The invitations were accepted by forty-five teachers; twenty-three science opinion leaders and twenty-two nonleaders. The program sessions were conducted on three consecutive Saturdays in March 1969 from 9 A.M. to 1 P.M. in Peirce Science Center at Clarion State College. The purpose of the program was to involve the participants in experiences using the science teaching techniques and materials of ten innovative investigations characteristic of those produced by the three major elementary science curriculum development projects. The following subsections describe the program and the ten innovative investigations.

Program Description

The Science Inservice Program consisted of three sessions conducted and instructed by the investigator at Clarion State College on March 8, March 15, and March 22, 1969. During each session the forty-five participants were involved in several of ten innovative investigations. Each investigation was presented using the teaching techniques and materials recommended by the developing program. Participants, working individually and in small groups had experiences with the project materials and the methods of science. The sessions stressed scientific inquiry, were relaxed and informal and were characterized by much interaction and enthusiasm among the participants. Using the project materials and equipment, the participants were encouraged to explore, to discuss, and to ask questions. The investigator, acting as program instructor, assumed the teaching role suggested for each investigation by the developing project. Participants were encouraged to evaluate the

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[14] Ibid., p. 14.

TABLE 5

PERCENTILE RANK EQUIVALENTS FOR RAW SCORES ON THE MINNESOTA TEACHER ATTITUDE INVENTORY, FORM A.[15]

	Experienced Elementary Teachers				
		Systems with fewer than 21 teachers		Systems with 21 or more teachers	
Percentile Rank	Rural Teachers	2 years training	4 years training	2 years training	4 years training
99	112	110	107	108	114
95	91	88	98	98	103
90	76	76	90	87	100
80	62	64	72	74	88
75	57	56	67	69	82
70	51	54	62	63	79
60	42	44	51	52	70
50	32	34	41	43	60
40	23	19	29	33	49
30	11	7	17	22	42
25	7	-3	12	16	36
20	-2	-7	4	7	22
10	-23	-21	-26	-9	7
5	-38	-35	-30	-27	-18
1	-64	-67	-39	-48	-50
N	332	118	102	249	247
Mean	29.7	29.2	37.0	40.1	55.1
SD	38.1	38.6	39.4	37.2	36.7

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[15] *Ibid.*, p. 9.

investigations in terms of potential for use in their own classrooms.

Upon completion of all three sessions, the forty-five participants had been involved in each of the ten selected elementary science curriculum innovations in the manner suggested by the developing project. Attention had also been devoted to preparing the participants to use the teaching methods and materials in their own classrooms. Following is an outline of the program sessions as conducted.

Science Inservice Program

March 8, Session 1 - a. Welcome; Program Overview

b. Administration of Rokeach Dogmatism Scale and Minnesota Teacher Attitude Inventory.

c. Participant Involvement in Investigations A, B, C

March 15, Session 2 - Participant Involvement in Investigations D, E, F, G

March 22, Session 3 - a. Participant Involvement in Investigations H, I, J

b. Program Summary

Although forty-five teachers participated in the inservice program, only forty-one are actually included in the analyses. The data from four participants, three science opinion leaders and one nonleader, had to be cast out. Two of the science opinion leaders heeded the advice of their principals and were accompanied to the inservice program by several fellow teachers from their schools. Since additional participants from the science opinion leaders' schools could affect both adoption and diffusion within the schools, it was necessary to disregard the data from these schools. One science opinion leader and one nonleader who participated in the inservice program failed to return the level of adoption posttest thereby making it impossible to compute their level of adoption change scores.

Description of Innovations

Ten innovative investigations from the three major elementary science curriculum development programs were selected for inclusion in this study. Each was chosen because it exemplified the objectives, techniques, and materials advocated by the developing program. Each was included as a part of one of the Science Inservice Program sessions.

Selected from Science--A Process Approach (AAAS) were Investigations C, E, F, and J. Selected from the Elementary Science Study (ESS) were Investigations B, I, and G. Selected from the Science Curriculum Improvement Study (SCIS) were Investigations A, D, and H. Table six lists the investigation topics and their project origins. A more complete description of each may be found in Part I of the questionnaire located in the appendixes.

The ten innovations exhibit a number of specific characteristics. Their adoption would require a voluntary individual decision by the elementary teacher. Rogers terms such a decision as optional and describes it as a type of decision made when an individual is free to make a final adoption-rejection choice but may be influenced by the norms of the social system in reaching a decision.[16] The decision, by an individual teacher, to use a class science investigation as a teaching method is an example of an optional decision.

The innovative investigations have divisibility or may be tried on a limited basis. It is not necessary to adopt them as a complete package. As Rogers points out, "new ideas that can be tried on the installment plan will generally be adopted more rapidly than innovations that are not divisible."[17] Marsh found that teachers adopted Physical Science Study Committee (PSSC) physics more rapidly because they could incorporate it into their program a bit at a time.[18] The selected innovations also lack complexity and exhibit high communicability. They are relatively easy to understand and use and the results may be easily observed and communicated to other teachers.

To encourage the evaluation and trial of the ten investigations in the participants' classrooms, each participant was supplied with a take-home package of materials for each of the ten investigations. For example, for investigation B concerning electricity and magnetism each participant was provided with a take-home packet containing a dozen flashlight cells, a dozen bulbs, bare and insulated copper wire, fahnestock clips, and steel spikes. After each program session the participants received materials related to the investigations conducted during that particular session. Each packet contained materials in sufficient quantities for implementing the investigations in the participant's own classroom. Additional materials and replacement items could be obtained inexpensively from supermarkets, hardwares, five-and-ten stores, and pet shops or could be brought from home. After having been provided with investigative experiences and materials for the ten investigations, each participant was then in a position to evaluate the potential of the innovations and make a decision concerning a trial in his own classroom.

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[16] Everett M. Rogers, "Toward a New Model for Educational Change" (paper presented at the Conference on Strategies for Educational Change, Washington, D.C. November 8-9, 1965), p. 10.

[17] Rogers, Diffusion of Innovations, p. 131.

[18] Paul E. Marsh, "Wellsprings of Strategy: Considerations Affecting Innovations by the PSSC" in Innovations in Education, ed. by Matthew B. Miles (Teachers College, Columbia University, 1964), p. 265.

TABLE 6

SCIENCE INSERVICE PROGRAM INVESTIGATIONS TOPICS

Investigation	Topic	Project Origin	Reference Source	Session Presented
A	Mr. O. - Relativity	SCIS	Relativity, Teachers' Guide	1
B	Electricity and Magnetism	ESS	Batteries and Bulbs	1
C	Inferrings the Characteristics of Packaged Articles	AAAS	Science--A Process Approach, Part Three	1
D	Life Cycles	SCIS	Life Cycles, Teachers' Guide	2
E	Identifying Materials	AAAS	Science--A Process Approach, Part Five	2
F	Controlling Variables	AAAS	Science--A Process Approach, Part Six	2
G	Mealworms	ESS	Behavior of Mealworms Teachers'Guide	2
H	Classification	SCIS	SCIS Elementary Science Sourcebook	3
I	Drops and Heapings	ESS	Kitchen Physics, Teachers'Guide	3
J	Describing the Motion of a Bouncing Ball	AAAS	Science --A Process Approach, Part Four	3

COLLECTION OF DATA

Data collected in this investigation consisted of responses to the following measures: a pretest-posttest level of adoption questionnaire, a sociometric measure of science opinion leadership, the Rokeach Dogmatism Scale, and the Minnesota Teacher Attitude Inventory. The following subsections describe the procedures by which the measures were administered.

Selection of Elementary Schools

On December 2, 1968, the superintendent of schools in each county in Region F was requested to provide information pertaining to the elementary schools in his county. The information requested included names and addresses of school systems and individual elementary schools, of administrative personnel, and of teachers in each individual elementary school, including grade level taught. Two of the five superintendents had compiled a directory including the information requested. The three others supplied only the names and addresses of the school systems located within their respective counties. In these counties a letter was sent to each chief school administrator requesting the necessary information. Sample letters to the county superintendents and chief school administrators are included in the appendixes.

From the information supplied by the administrators, all elementary schools in Region F having six or more regular classrooms were identified and constituted the population of 112 schools from which thirty Class 1 and thirty Class 2 schools were drawn. The chief school administrators and the elementary principals of the school districts in which the sixty schools were located were contacted to obtain their cooperation in the investigation. On January 9, 1969, each administrator received a letter which described the investigation and requested approval to proceed with the study in his district. The letter description was very general to preclude the possibility of participants making biased responses due to prior awareness of the exact nature of the study. A sample copy of the letter to administrators appears in the appendixes.

Administration of Questionnaire Parts I and II

After receiving administrative approval on January 24, 1969 all 618 teachers in the sixty Class 1 and Class 2 schools were sent a letter of transmittal and a two-part questionnaire consisting of Part I, a pretest measuring teacher level of adoption of ten selected innovative science investigations, and Part II, a sociometric measure of science opinion leadership based on a school-specific roster. Sample copies of the letter of transmittal and questionnaire appear in the appendixes.

Each of the 618 teachers was requested to complete the questionnaire and return it to the investigator. On February 10, 1969, a followup letter was sent to all teachers who had not responded to the first letter. A total of 528 teachers or 85.4 per cent returned the questionnaire. Of those returned, 492 or 79.6 per cent were fully completed and useable in the study. Thirty-six of the responses could not be used, the major stated reason being that the respondent did not teach science. Upon receipt of the useable questionnaires the scores were tabulated. Part I of the questionnaire yielded data relative to the level of adoption of ten selected elementary science curriculum innovations among teachers in the sixty schools prior to the Science Inservice Program. Part II, the school-specific sociometric measure, revealed the identity of the science opinion leaders and nonleaders in each of the sixty schools.

Measures Administered During the Inservice Program

Thirty elementary teachers from the Class 1 schools, identified as science opinion leaders by responses on Part II, the sociometric measure of science opinion leadership, were invited to participate in the Science Inservice Program. Thirty nonleaders from the Class 2 schools, similarly identified by sociometric responses, were also invited to participate in the inservice program. A total of forty-five teachers; twenty-three science opinion leaders and twenty-two nonleaders, participated in the program. The Rokeach Dogmatism Scale and the Minnesota Teacher Attitude Inventory were administered to the forty-five participants during the first ninety minutes of the first Science Inservice Program session on March 8, 1969. Scores on both of these measures were correlated with the participants' change scores on the measure of level of adoption of the ten science innovations.

Administration of the Level of Adoption Posttest

On May 31, 1969 ten weeks after the completion of the Science Inservice Program, Part I of the level of adoption questionnaire, administered now as a posttest, and a letter of transmittal were mailed to all 492 elementary teachers in the sixty Class 1 and Class 2 schools who had completed the pretest. The posttest was returned by 432 teachers or 87.8 per cent of the teachers to whom it was sent. Useable returns numbered 429. Table seven summarizes the numbers of questionnaires sent and the totals and per cent of questionnaires returned.

TABLE 7

NUMBERS OF QUESTIONNAIRES SENT AND TOTALS AND PERCENT OF QUESTIONNAIRES RETURNED

Questionnaire	Total Sent	Total Returned	Percent Returned	Total Useable Returns	Percent Useable Returns
Questionnaire, Part I Level of Adoption Pretest	618	528	85.4	492	79.6
Questionnaire, Part II Sociometric Measure of Science Opinion Leadership	618	523	84.6	476	77.0
Questionnaire, Part I Level of Adoption Posttest	492	432	87.8	429	87.4

After the respondents' posttest scores were tabulated, the pretest level of adoption scores were subtracted, algebraically, from the posttest level of adoption scores to yield change scores for the science opinion leaders and nonleaders and for the teachers in their respective schools. Change scores were computed for 20 science opinion leaders and 134 teachers in the schools which they represented. Similar scores were computed for 21 nonleaders and 119 teachers in the schools which they represented. The change scores thus derived provided data necessary to test the hypotheses set forth in this study.

METHODS OF DATA ANALYSES

The first two hypotheses concerning the differential levels of adoption of science teaching innovations between the science opinion leaders and nonleaders and the differential levels of adoption between the teachers in the schools which each group represented were tested statistically by a Model I single classification, completely randomized analysis of variance (anova) for unequal sample sizes.[19] Prior to testing hypotheses one and two a Student's t-test for uncorrelated data had been applied to test the equality of the means of the pretest level of adoption measure between the science opinion leaders and nonleaders and between the teachers in the schools represented by each group. Hypotheses three and four, concerning the correlations between the inservice program participants' change scores on a measure of level of adoption and their scores on the Rokeach Dogmatism Scale and on the Minnesota Teacher Attitude Inventory, were each tested by a 2 X 2 contingency table. The unadjusted values of X^2 were calculated for each test.[20] The level of significance at which all hypotheses were tested was .05. Table eight summarizes the hypotheses tested and the models used for data analyses.

RESULTS

The data collected by the methods described in the previous section are presented and discussed in this section. The first subsection is devoted to a description of the t-tests which were employed to test for significant differences in pretest level of adoption scores between science opinion leaders and nonleaders and between the teachers in their respective schools. Presented in each of the next subsections are the results of the analyses of data which tested each null hypothesis. The subsequent subsection includes a discussion of the results. Additional data pertinent to the analyses are embodied in the appendices.

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[19] C. C. Li, Introduction to Experimental Statistics (New York: McGraw Book Company, 1964), pp. [illegible].

[20] George W. Snedecor, Statistical Methods (Ames, Iowa: The Iowa State University Press, 1956), pp. [illegible].

TABLE 8

SUMMARY OF HYPOTHESES AND MODELS USED TO ANALYZE DATA

	Statement of Hypotheses	Models Used for Analyzing Data
H_{o1}	Science opinion leaders who participated in an inservice program dealing with innovative science teaching techniques and materials will adopt no more of the innovations than nonleaders who participated in the same program.	Analysis of variance $\alpha = .05$
H_{o2}	Teachers from schools which were represented in a science inservice program by science opinion leaders will adopt no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders.	Analysis of variance $\alpha = .05$
H_{o3}	Scores on the Rokeach Dogmatism Scale are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.	2 X 2 contingency table $\alpha = .05$
H_{o4}	Scores on the Minnesota Teacher Attitude Inventory are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.	2 X 2 contingency table $\alpha = .05$

COMPARISONS OF PRETEST LEVEL OF ADOPTION SCORES

Before hypotheses one and two were tested, analyses were conducted to determine whether there were significant differences in pretest level of adoption scores between the science opinion leaders and nonleaders and between the teachers in the schools which each group represented. Two separate t-tests for uncorrelated data were computed to determine if the two groups were significantly different in their levels of adoption before treatment.[1] A t-test was computed on the pretest level of adoption scores of the twenty science opinion leaders and the twenty-one nonleaders. A similar test was computed on the pretest level of adoption scores of the 134 teachers in the Class 1 schools and the 119 teachers in the Class 2 schools. The results supported that there were no significant differences in the pretest level of adoption scores between the science opinion leaders and nonleaders and no significant differences in the scores between the teachers in the schools which each group represented. The science opinion leaders and the teachers in their schools showed no particular advantage over nonleaders and the teachers in their schools with respect to pretest level of adoption scores. The original data relevant to these analyses are included in the appendixes.

Presented in each of the following subsections are the results of the analysis of data for each of the four hypotheses included in this investigation. The original data pertinent to the analyses are located in the appendixes.

DIFFERENTIAL ADOPTION BETWEEN SCIENCE OPINION LEADERS AND NONLEADERS

A science opinion leader is an elementary teacher in an individual school selected by his peers as the teacher from whom they would seek advice and information concerning new science teaching methods and materials. A review of the literature concerning the adoptive behavior of opinion leaders suggests that opinion leaders generally adopt innovations before nonleaders. Teachers designated as science opinion leaders by their fellow teachers were expected to be more innovative than teachers not so designated.

The null hypothesis H_{o1} stated that science opinion leaders who participated in an inservice program dealing with innovative science materials and teaching techniques would adopt no more of the innovations than nonleaders who participated in the same program. A Model I single classification, completely randomized analysis of variance was used to test hypothesis H_{o1}. The results are summarized in Table nine.

The analysis failed to produce an F statistic that reached the assigned level of significance. This leads one to conclude that science opinion leaders who participated in an inservice program dealing with innovative science teaching techniques and materials adopted no more of the innovations than nonleaders who participated in the same program.

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[1] George Simpson, Anne Roe, and Richard C. Lewontin, Quantitative Zoology (New York: Harcourt, Brace, and World, Inc., 1960), pp. 172-176.

TABLE 9

ANALYSIS OF VARIANCE DATA FOR THE CHANGE SCORES ON A MEASURE OF LEVEL OF ADOPTION OF SCIENCE INNOVATIONS BETWEEN SCIENCE OPINION LEADERS AND NONLEADERS

Source of Variation	df	SS	MS	F
Between Groups	1	57.14	57.14	1.28 NS
Within Groups	39	1736.61	44.53	
Total	40	1793.75		

$F_{.05}(1,39) = 4.09$

$F_{.01}(1,39) = 7.33$

DIFFERENTIAL ADOPTION BETWEEN TEACHERS IN SCHOOLS REPRESENTED BY SCIENCE OPINION LEADERS AND TEACHERS REPRESENTED BY NONLEADERS

Research evidence appears to indicate that the personal influence exerted by opinion leaders affects the adoption decisions of others. The adoption of science curriculum innovations by a science opinion leader may encourage and stimulate the adoption of the innovations by other teachers within his school. The null hypothesis H_{o2} stated that teachers from schools which were represented in a science inservice program by science opinion leaders would adopt no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders. A Model I single classification, completely randomized analysis of variance was used to test hypothesis H_{o2} and Table ten summarizes the results.

TABLE 10

ANALYSIS OF VARIANCE DATA FOR THE CHANGE SCORES ON A MEASURE OF LEVEL OF ADOPTION OF SCIENCE INNOVATIONS BETWEEN TEACHERS IN SCHOOLS REPRESENTED BY SCIENCE OPINION LEADERS AND TEACHERS IN SCHOOLS REPRESENTED BY NONLEADERS

Source of Variation	df	SS	MS	F
Between groups	1	38.48	38.48	0.996NS
Within groups	251	9692.69	38.62	
Total	252	9731.17		

$F_{.05}(1,251) = 3.88$

$F_{.01}(1,251) = 6.75$

The analysis did not produce an F statistic that reached the assigned level of significance; therefore, it may be concluded that teachers from schools which were represented in a science inservice program by science opinion leaders adopted no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders.

CORRELATION BETWEEN THE ROKEACH DOGMATISM SCALE AND CHANGE IN LEVEL OF ADOPTION

According to Rokeach, a person's receptivity to new ideas is a function of a personality variable known as dogmatism.[2] A closed-minded or highly dogmatic person is less likely to accept new ideas than an open-minded or low dogmatic person. A highly dogmatic person resists change while a low dogmatic person is more open to change. Knowledge about a person's degree of dogmatism may enable predictions about his behavior in the adoption of innovations. The level of adoption of science teaching innovations may change more for elementary teachers who score low on the Rokeach Dogmatism Scale than for teachers who score high.

Using the mean score on the Rokeach Dogmatism Scale and the mean change in level of adoption as mid-points, the forty-one inservice program participants were dichotomized into high and low groups on both measures and the results were cast on a 2 X 2 contingency table. The

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[2] Rokeach, The Open and Closed Mind, pp. 54-70.

2 X 2 contingency table was employed to test null hypothesis H_{o3} which stated that scores on the Rokeach Dogmatism Scale are not significantly correlated with change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study. The unadjusted chi-square value was computed. The results are summarized in Table eleven.

TABLE 11

2 X 2 CONTINGENCY TABLE ANALYSIS OF THE CORRELATION BETWEEN SCORES ON THE ROKEACH DOGMATISM SCALE AND CHANGE IN LEVEL OF ADOPTION OF SCIENCE INNOVATIONS

	Change in Level of Adoption		
Scores on Rokeach Dogmatism Scale	High	Low	
High	6	14	20
Low	13	8	21
	19	22	41

$X^2 = 4.19$

df = 1 $0.05 > P > 0.025$

The resulting chi-square value demonstrated significance at the 0.05 level; therefore, one may conclude that scores on the Rokeach Dogmatism Scale are significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study.

CORRELATION BETWEEN THE MINNESOTA TEACHER ATTITUDE INVENTORY AND CHANGE IN LEVEL OF ADOPTION

The use of new science curriculum techniques and materials requires a classroom social atmosphere characterized by interaction and cooperation between pupils and between pupils and teacher. A teacher committed to the innovations must create a climate of permissiveness necessary to support free inquiry. Pupils must be encouraged, guided, and questioned in open-ended investigations which involve them in the utilization of science processes. Teacher adoption of science curriculum innovations, therefore, may be dependent upon the type of social atmosphere maintained in their classrooms. Teachers who do not view pupil inquiry and freedom as a threat might adopt the innovations more readily than teachers who are more dominating and restrictive. Since the *Minnesota Teacher Attitude Inventory* has long been used as a predictor of the type of social atmosphere a teacher maintains, it was speculated that teachers who scored high on the *MTAI* (indicating their capability in establishing cooperative and mutual relationships with their pupils) would change more on the measure of level of adoption than teachers who scored low on the *MTAI* (indicating a more dominating and authoritative classroom behavior).

The mean score on the *MTAI* and the mean change on level of adoption were used as mid-points to dichotomize the forty-one inservice program participants into high and low groups on each measure. The results were cast on a 2 X 2 contingency table. The table was used to test null hypothesis H_{o4}: scores on the *MTAI* are not significantly correlated with change scores on a measure of level of adoption of science innovations among participants in an inservice program conducted as a part of this study. The unadjusted chi-square value was calculated. Table twelve summarizes the results of the analysis.

Since the chi-square value failed to reach the assigned level of significance, it may be concluded that scores on the *MTAI* are not significantly correlated with change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study.

TABLE 12

2 X 2 CONTINGENCY TABLE ANALYSIS OF THE CORRELATION BETWEEN SCORES ON THE *MINNESOTA TEACHER ATTITUDE INVENTORY* AND CHANGE IN LEVEL OF ADOPTION OF SCIENCE INNOVATIONS

	Change in Level of Adoption		
Scores on MTAI	High	Low	
High	9	12	21
Low	10	10	20
	19	22	41

$X^2 = 0.21$

df = 1 $0.9 > P > 0.5$

Table thirteen summarizes the data analyses for the four hypotheses tested in this study. The findings are discussed in the following subsection.

TABLE 13

SUMMARY OF DATA ANALYSES FOR EACH HYPOTHESIS TESTED

	Hypotheses Tested	Models Used for Analyzing Data	Results Based Upon $\alpha = .05$
H_{o1}	Science opinion leaders who participated in an inservice program dealing with innovative science materials and teaching techniques will adopt no more of the innovations than nonleaders who participated in the same program.	analysis of variance	no significant difference
H_{o2}	Teachers from schools which were represented in a science inservice program by science opinion leaders will adopt no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders.	analysis of variance	no significant difference
H_{o3}	Scores on the Rokeach Dogmatism Scale are not significantly correlated with change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study.	2 X 2 contingency table	a significant difference
H_{o4}	Scores on the Minnesota Teacher Attitude Inventory are not significantly correlated with change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study.	2 X 2 contingency table	no significant difference

DISCUSSION OF THE FINDINGS

The purpose of this exploratory study was to examine a diffusion strategy for science education which employed teacher opinion leaders and teachers selected on the basis of scores on certain social-psychological measures to adopt and spread innovations in science education methods and materials. It was generally hypothesized that if such persons could be identified and encouraged to adopt science teaching innovations such as those produced by the science curriculum projects, then their adoption might stimulate other teachers within their schools to adopt and diffuse the innovations. The findings of each hypothesis analyzed in the study are discussed in the subsections which follow.

Differential Adoption Between Science Opinion Leaders and Nonleaders

Table nine demonstrated that science opinion leaders who participated in an inservice program dealing with innovative science teaching techniques and materials adopted no more of the innovations than nonleaders who participated in the same program. The analysis of the data indicated that the identification of science opinion leaders and the concentration of inservice efforts upon them offered no advantage for gaining the adoption of science teaching innovations in the population examined in this study. Perhaps this finding was due to norms regarding change in general which existed in the population prior to the study and which may have acted as an intervening variable between change in adoption level and science opinion leadership. The two theoritical types of norms usually described in the literature are traditional and modern. A modern orientation is usually associated with acceptance of innovations whereas a traditional orientation is not. Rogers has pointed out that the norms of a social system affect an individual's decision to adopt or not adopt innovations. He cites considerable empirical evidence which suggests that individuals in modern systems are more likely to change than individuals in traditional systems.[3] Furthermore, it was reported in Introduction of this study that opinion leaders conform more closely to social system norms than the average member. Evidence was also cited which noted that opinion leaders in traditional systems were relatively less innovative than nonleaders. Although measurements of Region F's norms for orientation to chage in general were not included as a part of this study, the area from which the population was drawn can be described as traditional. The five counties, if considered as a homogenous social system, are isolated from major cities, sparsely settled, have declining populations, and are generally economicaly depressed. Schools are not wealthy and expend most of their resources to maintain the status quo. Teachers are local rather than cosmopolite. If it can be assumed that the prior state norms of Region F are traditional and not oriented to change and that such norms determine the innovativeness of opinion leaders, then it might reasonably be expected that science opinion leaders would not deviate very much from the system's norms. Furthermore, on the measure of level of adoption employed in this study the mean change scores for the twenty science opinion leaders and twenty-one nonleaders were, respectively, +8.4 and +10.8 out of scores which ranged from -2 to +24. The mean change scores may suggest that the science opinion leaders have been less innovative than the nonleaders - a characteristic of traditional systems. It would be interesting and worthwhile to compare the findings of this study with one replicated in an area with previously identified modern norms for change.

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[3] Rogers, Diffusion of Innovations, pp. 57-75.

Differential Adoption Between Teachers in Schools Represented by Science Opinion Leaders and Teachers Represented by Nonleaders

The analysis of data depicted in Table ten indicated that teachers from schools which were represented in a science inservice program by science opinion leaders adopted no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders. Several factors may have contributed to these findings. The sociometric measure of science opinion leadership employed in this study requested the respondent to indicate the colleagues to whom he *would* go for advice or information about newly developed methods and materials for teaching science. It is quite possible that teachers may look upon other teachers as leaders in science but seldom if ever actually obtain such information from them. Such a break in the communication network would certainly inhibit the spread of innovations within a school and would apply more or less equally to both groups.

A related factor is suggested by Lippitt who indicates that teachers are reluctant to share with their colleagues. In a study of ten elementary and secondary schools in Michigan, he found that colleagues in the same building did not share their classroom innovations.[4] Such a lack of openness of communication restricts the sharing of ideas and suppresses support for innovations which merit evaluation. A similar lack of communication may have been operative in this study and may have been an inhibiting factor preventing diffusion among both groups of teachers. Such a possibility may be worth considering in a future study.

Another factor which should be considered is the length of time required for teachers to pass through the adoption process. Such time may be measured in terms of days, months, or years. Although the innovations included in this study were deliberately selected because they could easily be adopted in a relatively short time period, it is quite possible that not enough time was permitted to elapse between the introduction of the innovations and the final measure of their adoption. The diffusion period required for an innovation to reach complete adoption is, at least partly, a function of the length of the adoption period for individual adopters. As the adoption period becomes proportionately longer for individual teachers, the diffusion period will likely become proportionately longer.

In considering a similar factor related to time, reference is made to Figure One, The Normal Diffusion Curve, included in the Introduction. It is noted that the S-shaped curve includes a gradually ascending first portion, a rapidly ascending second portion, and a gradual leveling off at complete adoption. It is quite possible that acceptance of the science teaching innovations had not yet begun to occur at the increased rate depicted by the second portion of the curve, thereby resulting in a premature estimate of diffusion. It appears evident that the time duration in both the adoption and diffusion processes merits further study.

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[4] Ronald Lippitt, "The Youth Culture, The School System, and The Socialization Community," in Albert J. Reiss (ed.) *Schools in a Changing Society* (New York: The MacMillan Company, 1966), p. 103.

Correlation Between the Rokeach Dogmatism Scale and Change in Level of Adoption

The 2 X 2 contingency table analysis shown in Table eleven revealed a Chi-square value significant at the 0.05 level. The data analysis indicated that scores on the Rokeach Dogmatism Scale are significantly correlated with change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study. It appears that an inverse relationship exists between scores on the Rokeach Dogmatism Scale and change in level of adoption of science teaching innovations. Most teachers who scored high on the Rokeach Dogmatism Scale scored low on change in level of adoption Most teachers who scored low on the Rokeach Dogmatism Scale scored high on change in level of adoption. Although the null hypothesis was rejected, it should be noted that due to the exploratory nature of the study and the relatively small sample size and low cell frequencies involved in the analysis, the findings should be regarded as tentative. The findings do indicate, however, that the relationship between dogmatism and the adoption of innovations is certainly worthy of further exploration.

Correlation Between the Minnesota Teacher Attitude Inventory and Change in Level of Adoption

Since the Chi-square value depicted in Table twelve did not achieve the assigned level of significance, it was concluded that scores on the Minnesota Teacher Attitude Inventory are not significantly correlated with change scores on a measure of level of adoption of science teaching innovations. Although the MTAI may be used to measure classroom social atmosphere, no evidence exists to support the contention that the instrument may also be used to predict whether a teacher will adopt modern science curriculum innovations. The MTAI was designed to measure a single teacher attribute; however, the implicit assumption that all 150 items do in fact measure a single unitary trait has been questioned by Horn and Morrison.[5] Their factor-analytic study of the MTAI yielded evidence which suggested the existence of five covarying patterns of items rather than the single dimension. Perhaps a productive area for further research would be to explain the relationship of each of the factors to the adoption of science teaching innovations. Consideration could also be given to the use of parcel factor analysis, as described by Cattell and Horn,[6] to tie together in a priori scales small subsets of items particularly related to the teaching behavior associated with the science curriculum innovations.

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[5] John L. Horn and W. Lee Morrison, "Dimensions of Teacher Attitudes," *Journal of Educational Psychology*, LVI (1965), pp. 118-125.

[6] R. B. Cattell and J. Horn, "An Integrating Study of Factor Structure of Adult Attitude - Interests," *Genetic Psychology Monographs*, LXVII (1963), pp. 89-149.

CONCLUSIONS

The general intent of this investigation was to explore a diffusion strategy for science education. The purpose was two-fold. The first was to determine whether teachers designated as science opinion leaders adopted and diffused more innovations in science education methods and materials than teachers not designated as science opinion leaders. The second was to determine whether the adoption of the innovations was significantly correlated with scores achieved by teachers on either the Rokeach Dogmatism Scale or the *Minnesota Teacher Attitude Inventory*.

The following findings were established on the basis of the data analyzed and presented in this study.

1. There were no significant differences in pretest level of adoption scores between the science opinion leaders and nonleaders or between the teachers in the schools which each group represented.

2. Science opinion leaders who participated in an inservice program dealing with innovative science teaching techniques and materials adopted no more of the innovations than nonleaders who participated in the same program.

3. Teachers from schools which were represented in a science inservice program by science opinion leaders adopted no more of the science teaching innovations than teachers from schools which were represented in the same inservice program by nonleaders.

4. There was a significant correlation between scores on the Rokeach Dogmatism Scale and change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study.

5. There was no significant correlation between scores on the *Minnesota Teacher Attitude Inventory* and change scores on a measure of level of adoption of science teaching innovations among participants in an inservice program conducted as a part of this study.

On the basis of these findings, the following conclusions appear warranted.

1. The adoption of science teaching innovations by science opinion leaders and the teachers in their respective schools did not differ significantly from nonleaders and the teachers in their

respective schools. In the population studied, it appears that the adoption and diffusion of science teaching innovations could not be stimulated by selecting science opinion leaders as targets of innovational input and concentrating science inservice activities upon them.

2. The data analysis showed a significant correlation between scores on the Rokeach Dogmatism Scale and change in level of adoption of science teaching innovations among science inservice program participants. Most teachers who scored high on the dogmatism scale scored low on change in adoption level. Most teachers who scored low on the dogmatism scale scored high on change in adoption level. It appears that a negative correlation exists between dogmatism and the adoption of science teaching innovations. Although this finding should be regarded as tentative, the possibility of selecting low dogmatic teachers as points of innovational input deserves to be explored further.

3. Among the science inservice program participants, no significant correlation existed between scores on the *Minnesota Teacher Attitude Inventory* and change in level of adoption of science teaching innovations; therefore, it must be concluded that the *Minnesota Teacher Attitude Inventory* offers little promise as a tool for predicting whether elementary teachers will adopt science teaching innovations.

RECOMMENDATIONS

A significant gap exists between the development of science teaching innovations and their implementation in elementary schools. Additional research on the adoption and diffusion processes can narrow the gap by providing a base of empirical evidence upon which diffusion strategies can be built. The recommendations for future research included in this section are based upon the findings and conclusions of this study and on impressions acquired by the writer as the study was conducted.

1. Although traditional and modern norms for accepting innovations have been described and measured in areas such as rural sociology and anthropology, little is known about how they affect the adoption of innovations in education. Attention should be devoted to developing techniques for determining whether a school system's norms for accepting innovations are traditional or modern, how they got that way, and what effect they have upon the adoption and diffusion of innovations by teachers within the system.

2. The effect of teacher-administrator relationships on the adoption and diffusion processes needs to be examined. Discussions with teachers during the study revealed a concern for how their principals would react to the use of the innovations in their classrooms. Some teachers expressed a reluctance to use innovations in which pupils were free to become actively engaged in science investigations, discussions, or explorations because they feared that their principals would not look favorably

upon the apparent disorder associated with such methods. An attempt should be made to ascertain the relationship between the various roles that an elementary principal may play and the adoption decisions of his teachers. Are innovations more successfully implemented when the principal introduces the innovation and actively supports it than when he assumes a neutral or negative stance? If a teacher's perceptions of the principal's expectations affect his adoption decisions, does evidence exist to substantiate the perceptions or are they really manifestations of the teacher's own psychological barriers to change?

3. Future research should also focus upon methods for selecting science opinion leaders. Is the sociometric technique employed in this study a more effective technique than selection by judges' ratings or by the self-designation technique? Why are certain teachers chosen as science opinion leaders and do they, in fact, function as opinion leaders or do they exist in name only? Perhaps a more sensitive instrument should be devised to identify science opinion leaders.

4. Since the diffusion of innovations depends upon the flow of communication, the school communication channels and processes should be investigated. Perhaps elementary teachers do not communicate with each other about the teaching and learning that takes place in their classrooms and, therefore, do not know what their colleagues are doing. If a communication network does exist within a school, what is the relationship between the characteristics of the innovations introduced into it and the time required for diffusion?

5. Social-psychological instruments other than those utilized in this study could be employed or developed in an attempt to identify teachers who could serve as focal points for the introduction of science education innovations. Perhaps a specific instrument could be devised with the capability of predicting with reasonable accuracy whether a teacher would adopt science curriculum innovations.

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GLOSSARY

Adoption is a decision to continue full use of the innovation in the future.

Adoption process is the mental process through which an individual passes from first hearing about an innovation to final adoption. The adoption process is conceptualized in five stages or levels: awareness, interest, evaluation, trial, and adoption.

Change agent is a professional person who attempts to influence adoption decisions in a direction that he believes is desirable.

Classroom social atmosphere is the teacher-pupil interpersonal relationship which prevails in a classroom, i.e., teachers establish cooperative and mutual relationships with their students or they are dominating and authoritarian in their behavior.

Diffusion is the process by which an innovation spreads.

Diffusion process is the spread of a new idea from its source of invention or creation to its ultimate users or adopters.

Dogmatism is a personality variable which governs the person's receptivity to new beliefs about ideas, people, and places, and included the person's ability to evaluate information pertaining to each of these areas on its own merit.

Elementary science curriculum innovation is a newly developed method or material for teaching science in the elementary school produced by an elementary science curriculum development project such as Science--A Process Approach, Elementary Science Study, or Science Curriculum Improvement Study.

Innovation is an idea perceived as new by an individual.

Level of adoption is the particular stage in the adoption process at which an individual is located at a given point in time. The level of adoption is indicated by one of the five stages: awareness, interest, evaluation, trial, and adoption.

Nonleader is a teacher in an individual elementary school from whom other teachers do not seek advice and information about newly developed methods and materials for teaching science.

Science opinion leader is a teacher in an individual elementary school from whom other teaches seek advice and information about newly developed methods and materials for teaching science.

APPENDIX A

INSTRUMENTS USED TO GATHER DATA

GENERAL INFORMATION

A. Name of respondent (Miss) (Mrs.) (Mr.) ______________________________

B. Name and address of school in which you teach ______________

____

____

C. Circle the grade level which you teach K 1 2 3 4 5 6

D. Have you ever attended a workshop, in-service program, or institute specifically for science? ______Yes ______No

E. When this study is completed, would you like to receive a summary of the results? ______Yes ______No

GENERAL INSTRUCTIONS: This questionnaire is composed of two parts: Part I and Part II.

Part I consists of descriptions of ten elementary science investigations lettered A through J. You are invited to read each description and decide which one of the seven statements at the top of the page best describes your present feeling about and/or use of the investigation. Indicate that statement by circling one of the numbers which appears like this 1 2 3 4 5 6 7 for each description. For example, if after reading the description of investigation A and the statements at the top of the page, you decide that you hadn't heard of investigation A before you would then circle the number 1. However, if you are using or have used investigation A in your classroom but haven't decided if you'll use it again in the future, you would circle the number 6.

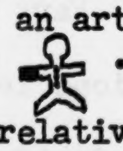
Part II requests that you place the numbers 1, 2, and 3 beside the names of individuals in your school to whom you would go for advice and information concerning newly developed methods and materials for teaching science in the elementary school.

PART I

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation A

This investigation concerns relativity or the positions and motions of objects relative to other objects. It involves the use of an artificial observer, Mr. O, who is made of paper and is shaped like this  . For the children, Mr. O becomes a central reference object. The position of any other object either at rest or in motion is described relative to Mr. O. Children are involved in individual or group activities such as discussing Mr. O's relative position, cutting out Mr. O figures, and manipulating Mr. O's position relative to other objects.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of

1 2 3 4 5 6 7 Investigation A.

Description of Investigation B

This investigation involves children in the study of electricity and magnets. Children work individually, in pairs or in small groups using materials such as flashlight cells, bulbs, wire, tape and nails. They investigate such things as ways to light a bulb using only a cell, a bulb, and a wire; what happens when more than one cell or bulb is used; and how to construct and use a simple electromagnet.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of

1 2 3 4 5 6 7 Investigation B.

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but I haven't tried it yet.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation C

The intention of this investigation is to encourage pupils to make careful, conscious reasoning about observations. The children must infer the characteristics of objects they cannot see. Objects such as chalk, pencils, marbles, erasers, pins, spoons, tacks, or stones are placed in containers such as cigar or shoe boxes. Children working in small groups observe, discuss, or infer the characteristics and identity of the objects in the boxes on the basis of hearing, touching, or lifting, smelling, etc.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation C.

1 2 3 4 5 6 7

Description of Investigation D

This investigation involves children in the study of the life cycles of flowering plants. Fruits such as tomatoes or bean and pea pods are examined and identified as sources of seeds. Children examine and count peas, corn, beans, or sunflower seeds. The seeds are germinated and the early growth of the embryo plant is observed. Seeds are planted in small drinking cups and children observe, discuss, measure, and record the growth and development of plants.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation D.

1 2 3 4 5 6 7

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation E

In this investigation, the children are given several common substances such as talcum powder, baking soda, and cornstarch which, on preliminary observation, seem alike. They are asked to treat them with other substances such as water, white vinegar or an iodine solution, to observe their behavior, and to record the data for future reference. The data are then used by the children in identifying known materials, and subsequently in the identification of a substance that is unknown to them.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation E.

1 2 3 4 5 6 7

Description of Investigation F

This investigation involves children in observing and measuring human reaction time. A piece of paper, yardstick, or meterstick is held between the thumb and fingers of a child and is then released. A measurement is then made of how far the paper or stick dropped before it was caught. Reaction times to such signals as light, sound, and touch are subjects of measurement. The children work together in small groups dropping and measuring, identifying variables, and providing controls.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation F.

1 2 3 4 5 6 7

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation G

In this investigation children observe and experiment with mealworms. Mealworms are the larvae of grain beetles, Tenebrio molitar, and grow to about one inch long and one-eighth inch in diameter. Children make undirected observations of the mealworm or seek to answer questions such as: Can a mealworm see? How do mealworms follow walls? How do they find a pile of bran? How can a mealworm be made to back up? In their attempts to solve these problems the pupils devise experiments, observe, measure, keep records, design and build simple equipment, attempt to control variables, and draw conclusions.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation G.

1 2 3 4 5 6 7

Description of Investigation H

In this investigation children are involved in classification and serial ordering. Objects or materials such as sandpaper, corks, wood, rocks, or minerals are grouped or classified on the basis of properties such as shape, size, color, or texture. Children work individually or in small groups observing and describing properties, developing classification systems, and ranking objects according to the degree to which they possess a certain property.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes your present feeling about and/or use of Investigation H.

1 2 3 4 5 6 7

Statements

1. This investigation is new to me; I hadn't heard of it before.
2. I've heard or read of this investigation, but haven't given it much thought.
3. I am considering using this investigation in my classroom, but haven't reached any conclusion on its value.
4. I doubt that this investigation would be of much value to me in my teaching situation.
5. This investigation looks promising for my teaching situation, but I haven't tried it yet.
6. I have used or am using this investigation in my classroom, but I haven't yet decided if I'll use it again in the future.
7. I have used or am using this investigation in my classroom, and I intend to use it again in the future.

Description of Investigation I

This investigation involves children in some simple experiments with eyedroppers and liquids such as water, soapy water, cooking oil, vinegar, etc. Liquid properties such as density, viscosity, surface tension, adhesion, and cohesion are isolated and explored. Individuals or small groups of children perform such activities as observing drops of different liquids, investigating the way different surfaces affect the size and shape of drops, determining if different liquids make different drop prints or if the distance a drop falls makes a difference in the size of the print, conducting "races" with different liquids on slanted waxed paper, and investigating what happens if a small piece of aluminum foil, cork, or toothpick has been placed on top of a "heap" of liquid. They discuss their observations and ideas and devise ways of testing to find out if their ideas are right.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes

1 2 3 4 5 6 7 your present feeling about and/or use of Investigation I.

Description of Investigation J

In this investigation the children observe, describe, and measure the motion of bouncing balls. Children work in small groups using assorted balls such as sponge rubber, ping-pong, or super balls. One child drops the ball while the others measure, discuss, and record data. They predict and determine the relationship between drop height of a ball to its bounce height and may construct bar graphs to show this relationship.

Directions: Please circle the one number at the left which corresponds with the statement at the top of the page which best describes

1 2 3 4 5 6 7 your present feeling about and/or use of Investigation J.

ROKEACH DOGMATISM SCALE

The following is a study of what the general public thinks and feels about a number of important social and personal questions. The best answer to each statement below is your personal opinion. We have tried to cover many different and opposing points of view; you may find yourself agreeing strongly with some of the statements, disagreeing just as strongly with others, and perhaps uncertain about others; whether you agree or disagree with any statement, you can be sure that many people feel the same as you do.

Mark each statement in the left margin according to how much you agree or disagree with it. Please mark every one.

Write +1, +2, +3, or -1, -2, -3, depending on how you feel in each case.

+1: I AGREE A LITTLE

+2: I AGREE ON THE WHOLE

+3: I AGREE VERY MUCH

-1: I DISAGREE A LITTLE

-2: I DISAGREE ON THE WHOLE

-3: I DISAGREE VERY MUCH

Reprinted from THE OPEN AND CLOSED MIND by Milton Rokeach, (Dogmatism Scale, Form E, pp. 72-80), c 1960 by Basic Books, Inc., Publishers, New York.

Write +1, +2, +3, or -1, -2, -3, depending on how you feel in each case.

+1: I AGREE A LITTLE
+2: I AGREE ON THE WHOLE
+3: I AGREE VERY MUCH

-1: I DISAGREE A LITTLE
-2: I DISAGREE ON THE WHOLE
-3: I DISAGREE VERY MUCH

____ 1. The United States and Russia have just about nothing in common.

____ 2. The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.

____ 3. Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.

____ 4. It is only natural that a person would have a much better acquaintance with ideas he believes in than with ideas he opposes.

____ 5. Man on his own is a helpless and miserable creature.

____ 6. Fundamentally, the world we live in is a pretty lonesome place.

____ 7. Most people just don't give a "damn" for others.

____ 8. I'd like it if I could find someone who would tell me how to solve my personal problems.

____ 9. It is only natural for a person to be rather fearful of the future.

____ 10. There is so much to be done and so little time to do it in.

____ 11. Once I get wound up in a heated discussion I just can't stop.

____ 12. In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.

____ 13. In a heated discussion I generally become so absorbed in what I am going to say that I forget to listen to what the others are saying.

____ 14. It is better to be a dead hero than to be a live coward.

____ 15. While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beetoven, or Shakespeare.

____ 16. The main thing in life is for a person to want to do something important.

Write +1, +2, +3, or -1, -2, -3, depending on how you feel in each case.

+1: I AGREE A LITTLE
+2: I AGREE ON THE WHOLE
+3: I AGREE VERY MUCH

-1: I DISAGREE A LITTLE
-2: I DISAGREE ON THE WHOLE
-3: I DISAGREE VERY MUCH

_____ 17. If given the chance I would do something of great benefit to the world.

_____ 18. In the history of mankind there have probably been just a hendful of really great thinkers.

_____ 19. There are a number of people I have come to hate because of the things they stand for.

_____ 20. A man who does not believe in some great cause has not really lived.

_____ 21. It is only when a person devotes himself to an ideal or cause that life becomes meaningful.

_____ 22. Of all the different philosophies which exist in this world there is probably only one which is correct.

_____ 23. A person who gets enthusiastic about too many causes is likely to be a pretty "wishy-washy" sort of person.

_____ 24. To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.

_____ 25. When it comes to differences of opinion in religion we must be careful not to compromise with those who believe differently from the way we do.

_____ 26. In times like these, a person must be pretty selfish if he considers primarily his own happiness.

_____ 27. The worst crime a person could commit is to attack publicly the people who believe in the same thing he does.

_____ 28. In times like these it is often necessary to be more on guard against ideas put out by people or groups in one's own camp than by those in the opposing camp.

_____ 29. A group which tolerates too much differences of opinion among its own members cannot exist for long.

_____ 30. There are two kinds of people in this world: those who are for the truth and those who are against the truth.

_____ 31. My blood boils whenever a person stubbornly refuses to admit he's wrong.

Write +1, +2, +3, or -1, -2, -3, depending on how you feel in each case.

+1: I AGREE A LITTLE
+2: I AGREE ON THE WHOLE
+3: I AGREE VERY MUCH

-1: I DISAGREE A LITTLE
-2: I DISAGREE ON THE WHOLE
-3: I DISAGREE VERY MUCH

_____ 32. A person who thinks primarily of his own happiness is beneath contempt.

_____ 33. Most of the ideas which get printed nowadays aren't worth the paper they are printed on.

_____ 34. In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.

_____ 35. It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.

_____ 36. In the long run the best way to live is to pick friends and associates whose tastes and beliefs are the same as one's own.

_____ 37. The present is all too often full of unhappiness. It is only the future that counts.

_____ 38. If a man is to accomplish his mission in life it is sometimes necessary to gamble "all or nothing at all."

_____ 39. Unfortunately, a good many people with whom I have discussed important social and moral problems don't really understand what's going on.

_____ 40. Most people just don't know what's good for them.

APPENDIX B

SUMMARY OF DATA ANALYZED FOR THE SCIENCE OPINION LEADERS AND NONLEADERS AND FOR THE TEACHERS IN THEIR RESPECTIVE SCHOOLS

TABLE 14

PRETEST, POSTTEST, AND CHANGE SCORES ON A MEASURE OF LEVEL OF ADOPTION OF SCIENCE INNOVATIONS FOR SCIENCE OPINION LEADERS AND NONLEADERS

	Science Opinion Leaders				Nonleaders				
School Code	Teachers Number	Pretest Score	Posttest Score	Change Score	School Code	Teacher Number	Pretest Score	Posttest Score	Change Score
LA	1	27	37	+10	NA	1	29	37	+ 8
LB	2	32	42	+10	NB	2	29	39	+10
LC	3	36	40	+ 4	NC	3	25	36	+11
LD	4	44	42	- 2	ND	4	22	44	+22
LE	5	30	47	+17	NE	5	32	41	+ 9
LF	6	32	34	+ 2	NF	6	34	43	+ 9
LG	7	18	35	+17	NG	7	18	35	+17
LH	8	22	40	+18	NH	8	30	38	+ 8
LI	9	11	31	+20	NI	9	39	41	+ 2
LJ	10	28	40	+12	NJ	10	29	33	+ 4
LK	11	22	42	+20	NK	11	23	47	+24
LL	12	33	40	+ 7	NL	12	32	44	+12

LM	13	36	36	0		NM	13	36	39	+ 3
LN	14	32	36	+ 4		NN	14	20	31	+11
LO	15	35	37	+ 2		NO	15	26	50	+24
LP	16	34	41	+ 7		NP	16	30	32	+ 2
LQ	17	31	39	+ 8		NQ	17	28	41	+13
LR	18	40	42	+ 2		NR	18	28	40	+12
LS	19	33	38	+ 5		NS	19	24	29	+ 5
LT	20	38	43	+ 5		NT	20	30	41	+11
						NU	21	24	33	+ 9

TABLE 15

PRETEST, POSTTEST, AND CHANGE SCORES ON A MEASURE OF LEVEL OF ADOPTION OF SCIENCE INNOVATIONS FOR TEACHERS IN SCHOOLS REPRESENTED BY SCIENCE OPINION LEADERS AND TEACHERS IN SCHOOLS REPRESENTED BY NONLEADERS

Teachers in Schools Represented by Science Opinion Leaders (N= 134)					Teachers in Schools Represented by Nonleaders (N= 119)				
School Code	Teacher Number	Pretest Score	Posttest Score	Change Score	School Code	Teacher Number	Pretest Score	Posttest Score	Change Score
LA	1	30	32	+ 2	NA	1	27	36	+ 9
	2	28	32	+ 4		2	40	40	0
	3	32	34	+ 2		3	43	50	+ 7
	4	27	32	+ 5		4	28	29	+ 1
	5	24	30	+ 6					
	6	18	32	+14	NB	1	20	27	+ 7
						2	10	10	0
LB	1	27	36	+ 9		3	18	18	0
	2	34	32	- 2		4	31	34	+ 3
	3	42	46	+ 4		5	33	25	- 8
	4	31	33	+ 2		6	10	10	0
	5	32	30	- 2					
	6	29	28	- 1	NC	1	29	33	+ 4
	7	36	34	- 2		2	30	31	+ 1
	8	26	38	+12					
	9	30	20	-10	ND	1	30	30	0
						2	32	29	- 3
LC	1	30	37	+ 7		3	30	10	-20
	2	24	31	+ 7		4	29	34	+ 5
	3	30	31	+ 7		5	25	25	0
	4	12	24	+12		6	29	31	+ 2
	5	42	40	- 2					
	6	29	28	- 1					

	7	26	22	- 4
	8	31	31	0
	9	29	28	- 1
	10	40	40	0
	11	25	25	0
LD	1	36	40	+ 4
	2	33	35	+ 2
	3	28	31	+ 3
LE	1	26	28	+ 2
	2	32	10	-22
	3	22	32	+10
	4	41	41	0
	5	41	41	0
	6	41	32	- 9
	7	27	26	- 1
	8	38	31	- 7
	9	30	32	+ 2
	10	33	26	- 7
	11	20	14	- 6
	12	36	43	+ 7
	13	24	28	+ 4
	14	16	16	0
LF	1	30	35	+ 5
	2	30	28	- 2
	3	24	38	+14
	4	33	34	+ 1
	5	25	22	- 3
	6	26	28	+ 2
	7	30	32	+ 2

NE	1	26	34	+ 8
	2	32	26	- 6
	3	25	24	- 1
	4	24	27	+ 3
	5	29	29	0
	6	46	40	- 6
	7	42	38	- 4
	8	32	23	- 9
NF	1	37	38	+ 1
	2	29	36	+ 7
	3	18	13	- 5
	4	33	32	- 1
NG	1	34	33	- 1
	2	26	28	+ 2
	3	26	33	+ 7
	4	29	30	+ 1
	5	17	19	+ 2
	6	10	30	+20
	7	29	29	0
	8	17	28	+11
	9	20	20	0
	10	10	16	+ 6
	11	28	29	+ 1
	12	25	29	+ 4
	13	34	34	0
NH	1	34	22	-12
	2	37	40	+ 3
	3	24	25	+ 1
	4	24	28	+ 4

TABLE 15--continued

Teachers in Schools Represented by Science Opinion Leaders (N = 134)					Teachers in Schools Represented by Nonleaders (N = 119)				
School Code	Teacher Number	Pretest Score	Posttest Score	Change Score	School Code	Teacher Number	Pretest Score	Posttest Score	Change Score
LG	1	30	29	- 1	NI	1	39	39	0
	2	28	28	0		2	24	25	- 1
	3	32	36	+ 4		3	24	28	+ 4
	4	27	32	+ 5		4	28	27	- 1
	5	19	30	+11		5	24	46	+22
	6	22	33	+11		6	32	32	0
	7	26	21	- 5		7	28	32	+ 4
	8	23	27	+ 4		8	22	22	0
	9	20	29	+ 9		9	28	28	0
						10	33	29	- 4
LH	1	22	24	+ 2		11	27	24	- 3
	2	38	37	- 1					
	3	18	28	+10	NJ	1	36	36	0
	4	42	37	- 5		2	40	36	- 4
	5	26	37	+11		3	29	29	0
						4	29	27	- 2
LI	1	26	28	+ 2		5	32	24	- 8
	2	29	28	- 1					
	3	33	36	+ 3	NK	1	34	33	- 1
	4	28	32	+ 4		2	22	27	+ 5
	5	34	32	- 2		3	38	37	- 1
	6	25	29	+ 4		4	27	31	+ 4
	7	19	25	+ 6		5	30	28	- 2
	8	25	30	+ 5		6	14	20	+ 6
						7	41	42	+ 1

LJ	1	24	22	- 2
	2	32	29	- 3
	3	10	10	0
	4	34	32	- 2
	5	34	32	- 2
	6	27	30	+ 3
	7	22	24	+ 2
	8	31	34	+ 3
	9	33	38	+ 5
	10	39	44	+ 5
LK	1	42	42	0
	2	28	34	+ 6
	3	31	39	+ 8
	4	28	36	+ 8
LL	1	22	25	+ 3
	2	21	25	+ 4
	3	30	38	+ 8
LM	1	32	28	- 4
	2	28	29	+ 1
	3	29	34	+ 5
	4	18	22	+ 4
	5	30	30	0
LN	1	12	31	+19
	2	18	23	+ 5
	3	20	20	0
LO	1	33	22	-11
	2	29	33	+ 4
	3	38	36	- 2
	4	30	27	- 3
	5	32	28	- 4

NL	1	27	26	- 1
NM	1	42	40	- 2
	2	34	24	-10
	3	36	26	-10
NN	1	30	26	- 4
	2	35	38	+ 3
	3	27	26	- 1
NO	1	38	37	- 1
	2	25	32	+ 7
	3	28	28	0
	4	34	26	- 8
	5	25	29	+ 4
NP	1	28	29	+ 1
	2	26	37	+11
	3	28	33	+ 5
	4	28	38	+10
	5	28	31	+ 3
NQ	1	34	31	- 3
	2	29	26	- 3
	3	32	25	- 7
	4	22	30	+ 8
NR	1	26	32	+ 6
	2	22	33	+11
	3	30	30	0
	4	40	32	- 8
	5	29	26	- 3
	6	37	40	+ 3
	7	28	31	+ 3
	8	13	27	+14
	9	30	36	+ 6
	10	23	25	+ 2
	11	17	26	+ 9

TABLE 15--Continued

Teachers in Schools Represented by Science Opinion Leaders (N = 134)					Teachers in Schools Represented by Nonleaders (N = 119)				
School Code	Teacher Number	Pretest Score	Posttest Score	Change Score	School Code	Teacher Number	Pretest Score	Posttest Score	Change Score
LP	1	32	26	- 6	NS	1	32	28	- 4
	2	34	33	- 1		2	37	32	- 5
	3	26	33	+ 7		3	30	32	+ 2
	4	28	17	-11		4	26	28	+ 2
	5	22	36	+14		5	30	35	+ 5
	6	29	36	+ 7		6	26	18	- 8
	7	37	28	- 9		7	18	20	+ 2
	8	20	20	0		8	22	28	+ 6
LQ	1	28	32	+ 4		9	16	26	+10
	2	32	29	- 3		10	29	30	+ 1
	3	25	26	+ 1	NT	1	35	35	0
	4	21	18	- 3		2	31	38	+ 7
	5	38	44	+ 6		3	12	29	+17
LR	1	24	30	+ 6		4	30	38	+ 8
	2	10	38	+28	NU	1	35	34	- 1
	3	37	38	+ 1		2	36	35	- 1
	4	10	30	+20		3	28	29	+ 1
	5	20	28	+ 8					
	6	23	24	+ 1					

LS	1	33	32	- 1
	2	34	40	+ 6
	3	33	31	- 2
	4	36	38	+ 2
	5	36	32	- 4
	6	28	23	- 5
	7	35	47	+12
	8	22	22	0
	9	31	28	- 3
	10	32	33	+ 1
LT	1	36	40	+ 4
	2	30	28	- 2
	3	22	24	+ 2

TABLE 16

SCORES ON THE ROKEACH DOGMATISM SCALE FOR SCIENCE INSERVICE PROGRAM PARTICIPANTS

Science Opinion Leaders			Nonleaders		
School Code	Teacher Number	Score	School Code	Teacher Number	Score
LA	1	112	NA	1	144
LB	2	173	NB	2	160
LC	3	149	NC	3	140
LD	4	128	ND	4	156
LE	5	137	NE	5	168
LF	6	126	NF	6	126
LG	7	164	NG	7	118
LH	8	152	NH	8	112
LI	9	148	NI	9	148
LJ	10	143	NJ	10	195
LK	11	100	NK	11	127
LL	12	173	NL	12	130
IM	13	120	NM	13	123
LN	14	170	NN	14	139
LO	15	145	NO	15	132
LP	16	144	NP	16	193
LQ	17	147	NQ	17	124
LR	18	174	NR	18	123
LS	19	137	NS	19	173
LT	20	166	NT	20	143
			NU	21	113

TABLE 17

SCORES ON THE MINNESOTA TEACHER ATTITUDE INVENTORY FOR SCIENCE INSERVICE PROGRAM PARTICIPANTS

Science Opinion Leaders			Nonleaders		
School Code	Teacher Number	Adjusted Score	School Code	Teacher Number	Adjusted Score
LA	1	209	NA	1	136
LB	2	185	NB	2	218
LC	3	191	NC	3	177
LD	4	231	ND	4	149
LE	5	206	NE	5	183
LF	6	205	NF	6	215
LG	7	156	NG	7	169
LH	8	187	NH	8	190
LI	9	107	NI	9	187
LJ	10	181	NJ	10	120
LK	11	235	NK	11	202
LL	12	221	NL	12	182
LM	13	227	NM	13	211
LN	14	166	NN	14	211
LO	15	205	NO	15	222
LP	16	202	NP	16	196
LQ	17	182	NQ	17	237
LR	18	217	NR	18	226
LS	19	199	NS	19	143
LT	20	221	NT	20	158
			NU	21	189

APPENDIX C

COMMUNICATIONS

December 2, 1968

Mr. Clark E. Ray
Clarion County Superintendent of Schools
Court House
Clarion, Pennsylvania 16214

Dear Mr. Ray:

During the next several months I shall be beginning an investigation concerning the adoption of elementary science innovations by elementary teachers in several counties, including Clarion.

For your county, I will need the names and addresses of school systems and individual elementary schools, of administrative personnel, and of teachers in each individual elementary school, including grade level taught, for this school year.

If you have compiled this information in the form of a directory or similar document, would you please send me a copy? If such information is not readily available, would you suggest where it may be obtained?

Your cooperation will be appreciated.

Sincerely,

Kenneth R. Mechling
Associate Professor of Biology

January 9, 1969

Mr. Gurney Fullerton
Supervising Principal
Jamestown Area Schools
Jamestown, Pennsylvania 16134

Dear Mr. Fullerton:

During the past decade, an increased interest in science education has spurred the development of innovative science curricula for elementary schools. Elementary science curriculum projects have developed numerous techniques, materials, and investigations which are designed to involve children in the processes of science. There is need for accurate information concerning the extent to which these developments are being used by elementary classroom teachers and how their use can be spread.

I am particularly desirous of obtaining your approval for contacting a number of your elementary teachers concerning their voluntary participation in an investigation. It is designed to determine the extent of use and spread of innovative science teaching techniques. For most teachers, this would only require fifteen to twenty minutes for completion and return of a questionnaire. After the information has been returned, one teacher from each school will be invited to participate in several Saturday morning sessions of a Science In-service Program held at Clarion State College. Each participant will learn about science curriculum developments and participate in selected investigations. Several months subsequent to the completion of the program, Part I of the questionnaire will again be administered by mail to all participating teachers. It is hoped that the results of the study will contribute to the improvement of preservice and in-service science education of elementary teachers.

All elementary teachers in sixty randomly selected schools in the five-county Region F area, including Clarion, Forest, Jefferson, Mercer, and Venango Counties, are being surveyed. Schools and teachers will not be identified by name. Questionnaire responses will be held in strictest confidence by the investigator.

The proposed investigation would involve all teachers from the following elementary schools: Jamestown.

It will be appreciated if you will complete the enclosed approval card and return it to me at your earliest convenience. Should you have further questions or comments, feel free to contact me.

Sincerely,

Kenneth R. Mechling
Associate Professor of Biology

Enclosures

January 1969

Dear Elementary Teacher:

During the past decade, an increased interest in science education has spurred the development of innovative science curricula for elementary schools. As a result, numerous investigations have been developed which are designed to involve elementary school children in the processes of science. No information concerning the extent to which teachers are aware of or are using the investigations is currently available. Yet, without such information to serve as a guideline, we cannot hope to increase the effectiveness of preservice or in-service programs of teacher education in science.

You, as an elementary classroom teacher, are in a position to furnish valuable information which will help establish guidelines for science education in Western Pennsylvania and, perhaps, all over the country. All elementary teachers in sixty randomly selected elementary schools in a five-county area, including Clarion, Forest, Jefferson, Mercer, and Venango Counties, are being surveyed. After the questionnaires have been returned, one teacher from each school will be invited to participate in three science in-service programs at Clarion State College.

Your chief school administrator and elementary supervisor have been informed of this survey and have indicated their approval for your participation. Schools and teachers will not be identified by name in the published report. You may be assured that the information you provide will be held in strictest confidence.

The enclosed questionnaire is constructed in such a way that it is easy to complete, and our trials indicate that it can be finished in less than twenty minutes. It would be greatly appreciated if you could take time out of your busy schedule to give the questionnaire your careful and thoughtful consideration.

Please return your completed questionnaire directly to us in the stamped, addressed envelope. It would be most helpful if it could be returned by February 7.

Thank you for your assistance.

Sincerely,

Kenneth R. Mechling
Associate Professor of Biology
Clarion State College

Enclosures 2

May 1969

Dear Elementary Teacher:

Several months ago you completed a questionnaire concerning your feeling about or use of ten selected innovative elementary school science investigations. Enclosed with this letter is the second and final portion of a survey which is being conducted by the U. S. Office of Education and Clarion State College. It is hoped that the information you provide will contribute to the development of effective in-service programs in science for elementary teachers.

This portion of the survey includes two questionnaires. The first is like the one you completed earlier and will provide data to validate the responses to the original questionnaire. The second, a brief one-page questionnaire, is to be completed only if you attended a workshop, in-service program, or institute specifically for science. It will be used to determine if science in-service programs affect the way science is taught in elementary classrooms and how such in-service programs can be improved.

I would appreciate it very much if you would complete and return the questionnaire to me at your earliest convenience. A summary of the survey results will be made available to you this fall.

I would like to express to you my most sincere thanks for giving your time and assistance in completing the questionnaires. I am very grateful for your cooperation and effort.

Sincerely,

Kenneth R. Mechling
Associate Professor of Biology

Enclosures 2